

Exhibit 3

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**UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK**

IN RE:

INTEREST RATE SWAPS ANTITRUST LITIGATION

16-MD-2704 (JPO)

16-MC-2704 (JPO)

This Document Relates to the Class Action.

EXPERT REPLY REPORT OF CHRISTOPHER L. CULP, PH. D

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HIGHLY CONFIDENTIAL**I. INTRODUCTION****A. Scope of Engagement and Summary of Primary Opinions**

1. On February 20, 2019, Plaintiffs submitted expert reports by Prof. Darrell Duffie (the “Duffie Report”¹) and Prof. Mark Grinblatt (later revised in an April 2, 2019 filing – the “Grinblatt Report”²). On June 18, 2019, I submitted a report on behalf of Defendants in response to certain analyses and opinions expressed in the Duffie and Grinblatt Reports (my “Opening Report”³), as did Prof. Michael Johannes (the “Johannes Report”⁴) and Prof. Peter Reiss (the “Reiss Report”⁵). On October 1, 2019, in response to Defendants’ filings and expert reports, Plaintiffs submitted additional expert reports by Prof. Duffie (the “Duffie Reply Report”⁶) and Prof. Grinblatt (later revised on October 11, 2019 – the “Grinblatt Reply Report”⁷) (hereinafter, collectively, the “Reply Reports”⁸).
2. I have been engaged by counsel for Defendants to review and respond to certain opinions in the Reply Reports. This report is not intended to address every area of disagreement I have with the Reply Reports. Instead, I limit my analyses, discussions, and opinions here to four key topics on which Plaintiffs’ experts focused in their Reply Reports: (1) their comments and

¹ Report of Darrell Duffie in Support of Class Plaintiffs’ Motion for Class Certification, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (February 20, 2019).

² Expert Report of Mark Grinblatt, Ph.D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (February 20, 2019). On April 2, 2019, Prof. Grinblatt submitted the Revised Expert Report of Mark Grinblatt, Ph.D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (April 2, 2019). All citations herein to the Grinblatt Report are to his April 2, 2019, revised report.

³ Expert Rebuttal Report of Christopher L. Culp, Ph.D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (June 18, 2019). See also Errata Sheet for the Expert Report Christopher L. Culp Dated June 18, 2019, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (August 22, 2019). The June 18, 2019, expert rebuttal report and August 22, 2019, errata to that report shall collectively be referred to as either the “Culp Report” or my “Opening Report.”

⁴ Expert Report of Michael Johannes, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (June 18, 2019).

⁵ Expert Rebuttal Report of Peter C. Reiss, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (June 18, 2019).

⁶ Reply Report of Darrell Duffie in Support of Class Plaintiffs’ Motion for Class Certification, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (October 1, 2019).

⁷ Expert Rebuttal Report of Mark Grinblatt, Ph.D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (October 1, 2019).

⁸ Corrected Expert Rebuttal Report of Mark Grinblatt, Ph.D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (October 11, 2019).

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criticisms of my analysis regarding the potential suitability of certain interest rate swaps (“IRS”) for anonymous all-to-all (“AA2A”) execution during Plaintiffs’ proposed Class Period (*i.e.*, beginning January 1, 2013); (2) their improper characterizations of minimum tick sizes and bid-ask spread data in central limit-order books (“CLOBs”) and my utilization of minimum tick sizes for Eurodollar futures in my Opening Report; (3) their flawed critiques of my opinions regarding Plaintiffs’ theories of substitution and propagation (as defined below); and (4) Prof. Grinblatt’s attempt in his Reply Report to defend the proposed but flawed “arithmetic compression” methodology that he articulated in the Grinblatt Report for estimating damages to putative Class Members for transactions that were uncleared and/or not executed on a Commodity Futures Trading Commission (“CFTC”)-registered Swap Execution Facility (“SEF”) or Designated Contract Market (“DCM”).⁹

3. Nothing in the Reply Reports has caused me to change any of my opinions expressed in my Opening Report. On the contrary, the new opinions that Profs. Duffie and Grinblatt offer in their Reply Reports are also flawed and incorrect. My primary reactions to Plaintiffs’ experts’ opinions in their Reply Reports are discussed in more detail in this report and can be summarized as follows:¹⁰

- **Potential Suitability of IRS for AA2A Trading:** In response to the Court’s ruling limiting this case to IRS products that were sufficiently standardized and liquid to be suitable for AA2A trading,¹¹ my Opening Report sought to determine how much standardization and how much liquidity on AA2A platforms an IRS product needs to generate bid-ask spreads sufficiently tight to attract customers from alternative execution platforms and mechanisms, such as voice trading and the request-for-quote (“RFQ”) protocol.
 - I found that even among the most standardized IRS, only two-, five-, and ten-year USD-denominated fixed/floating “benchmark” IRS were potentially suitable for execution on AA2A platforms.
 - In their opening reports, Profs. Duffie and Grinblatt failed to offer any specific criteria or test in response to the Court’s ruling. They likewise fail to do so in their Reply Reports, and, moreover, their attempts to criticize my assessment of IRS suitability for AA2A trading in my Opening Report are unfounded.

⁹ Unless otherwise indicated in this report, the nomenclature “off-SEF” is synonymous with “off-facility,” which refers to transactions that were not executed through *either* a CFTC-registered SEF or a DCM (which is colloquially the same as a CFTC-regulated U.S. futures exchange).

¹⁰ Footnote citations are omitted in this section for simplicity, but appear later in this report.

¹¹ Opinion and Order, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (July 28, 2017) (hereinafter “MTD Opinion & Order”), at fn41.

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- Standardization: As explained in my Opening Report, IRS are intended to be unique, customizable risk-management products, which leads to a high degree of product diversity. Although Profs. Duffie and Grinblatt and I disagree on how to characterize the extent and importance this diversity, we nevertheless agree that sufficient standardization of product terms is a prerequisite for an IRS product to be suitable for AA2A trading.
 - Prof. Grinblatt's minimum standardization criteria are overly broad. But even using Prof. Grinblatt's definition of what he believes constitutes a sufficiently standardized IRS, only 64 percent of USD-denominated fixed/floating IRS (and between 42 and 57 percent of fixed/floating IRS denominated in the other six major currencies) would have been standardized enough during the Class Period to have been suitable for AA2A execution.
- Liquidity: Plaintiffs' experts and I also agree that an IRS product needs sufficient liquidity to be suitable for AA2A trading, but they failed in their opening reports to propose a specific test to ascertain how much liquidity a particular IRS product needs in order to be suitable for AA2A trading. The Reply Reports criticized my proposed test for minimum sufficient liquidity but still do not propose any alternatives.
 - The test I proposed in my Opening Report seeks to measure how much liquidity is required to generate IRS spreads in AA2A trading that are equal to or less than spreads available through other execution protocols. It relies on a comparison of IRS volumes with volumes of Eurodollar futures (*i.e.*, the most comparable asset to IRS). Eurodollar futures are an exchange-traded product that is closely related to IRS – *viz.*, many USD-denominated IRS are based on the three-month London Interbank Rate (“3mLIBOR”), which is the same floating reference interest rate to which Eurodollar futures settle.
 - The least liquid Eurodollar futures contract with median bid-ask spreads equal to the CME exchange's minimum tick size (*i.e.*, the smallest possible bid-ask spread for that contract) trades an average daily notional volume of \$18.2 billion. The next most liquid Eurodollar contract trades an average daily notional volume of \$3.2 billion, with median bid-ask spreads that are *double* the minimum tick and *four times* the median bid-ask spread for IRS that trade via RFQ. To be conservative, I chose the \$3.2 billion figure as the minimum level of average daily notional trading that an IRS Product needs to be potentially suitable for AA2A execution. Based on this threshold, I determined that only the two-, five-, and ten-year USD fixed/floating “benchmark” IRS were potentially suitable for AA2A.
 - Plaintiffs criticize my test as novel and unsupported by the academic literature, but, in fact, my test is a comparable products analysis, which is a widely accepted methodology in the financial economics academic literature for asset pricing, performance evaluation, and the valuation of corporate transactions. Prof. Grinblatt himself utilizes a similar comparables methodology when he attempts in his Reply Report to estimate IRS spread compression in the but-for world, but his choice of comparators – *i.e.*, crude oil futures, dividend swaps, and Treasury securities – are far less comparable to IRS than Eurodollar futures (which are based on the same 3mLIBOR reference rate as most USD IRS).

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- Prof. Grinblatt conflates my *rationale* for choosing Eurodollar futures as a comparator with the *mechanics* of my liquidity test in arguing that I should have applied a multiplier to the IRS volumes I compared with Eurodollar futures volumes. I justify using Eurodollar futures contracts as a comparable for purposes of my test because their values and cash flows are driven by the same economic factors, such as the 3mLIBOR interest rate benchmark. To illustrate the close relationship between the IRS and Eurodollar futures, I explained that certain combinations of Eurodollar contracts – known as “strips” – can be used to replicate certain IRS. This does not mean, however, that my test should compare IRS volumes to volumes of Eurodollar *strips* instead of individual Eurodollar contracts. Eurodollar strips are created by trading individual Eurodollar futures contracts separately in a coordinated trading strategy, and are not themselves stand-alone traded products; there is no such thing as a single liquidity pool or observable bid-ask spread for a strip. As such, Prof. Grinblatt’s proposal to apply a multiplier to IRS trading volumes supposedly to make them comparable with Eurodollar futures strip volumes makes no sense and generates nonsensical empirical results – *e.g.*, longer-dated IRS appear inherently more liquid than shorter-dated IRS, which is demonstrably false.
- My liquidity analysis makes the neutral assumption that overall IRS volumes would not have changed in the but-for world versus the actual world. Plaintiffs’ experts both speculate that IRS trading volumes would have been far greater in the but-for world because of the introduction of buy-side AA2A trading but provide no empirical analysis to support that position. In fact, as discussed later in this report and my Opening Report, if introducing AA2A platforms in the but-for world resulted in liquidity fragmentation across platforms, overall IRS liquidity could have decreased. I thus have not changed my opinion that it was appropriate to assume for purposes of my analyses that IRS volumes would neither grow nor decline in the but-for world vis-à-vis the actual world.
- **Minimum Tick Sizes and Liquidity on AA2A Platforms:** In my Opening Report, I explained that minimum tick sizes serve as a floor on the bid-ask spread on CLOBs. I further explained that the need for exchanges to set a minimum tick size is one reason why it is unrealistic for Prof. Grinblatt to conclude that AA2A trading would cause IRS spreads to compress by 80 percent in the but-for world. In addition, I also rely on minimum tick sizes for purposes of my liquidity analysis to define the bid-ask spread at which AA2A-traded Eurodollar futures contracts are “fully liquid.” Plaintiffs’ experts contend that my reliance on minimum tick sizes renders my analysis flawed because minimum tick sizes are arbitrary and irrelevant. They are wrong.
 - DCMs and SEFs set minimum tick sizes in order to maximize liquidity, and are deliberate and systematic in their decisions to lower (or sometimes raise) minimum tick sizes in order to balance the desire by buy-side demanders of liquidity for lower bid-ask spreads vis-à-vis the need by liquidity providers to be assured of a minimum profit on transactions for which they are supplying liquidity.
 - CLOBs generally rely on time-price order matching algorithms, given the importance traders place on both of those aspects of execution. In that context, minimum tick sizes are a critically important determinant of liquidity on CLOBs.

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- The academic literature provides significant empirical support that the minimum tick size is related to measures of market liquidity, and generally substantiates that when platform operators change minimum tick sizes (usually because they are trying to attract greater liquidity), more transaction volume and liquidity results.
- **Product Substitution and Spread Propagation.** Profs. Grinblatt and Duffie maintain in their Reply Reports that *all* putative Class Members would have benefitted from more widespread trading of IRS on AA2A platforms, including those who would not have actually moved their trading to AA2A platforms (*e.g.*, because their trades were too customized to be suitable for AA2A).
 - **Substitution:** Plaintiffs' experts contend that users of more customized IRS during the Class Period would have benefitted by substituting their customized risk-management solutions for standardized AA2A-executed IRS at allegedly lower bid-ask spreads, which I define as their "Product Substitution" theory.
 - In my Opening Report, I showed that assessing the effects of Plaintiffs' experts' Product Substitution theory would require individualized inquiries because each IRS user has different sensitivities to "basis risk" (*i.e.*, the risks that arise when a hedge does not perfectly match the underlying risk).
 - Plaintiffs' experts appear to misunderstand my Product Substitution opinions and fail to recognize the inherently individualized nature of the balancing of potentially reduced trading costs against increases in basis risks and associated costs required to determine whether any particular putative Class Member would have substituted more standardized IRS in the but-for world for the less standardized IRS they traded in the actual world.
 - I never claimed that *no* Product Substitution would have occurred in the but-for world. Rather, I emphasized that individualized inquiries are critical to ascertain which putative Class Members would have been willing to assume greater basis risk in their hedge transactions in return for allegedly lower execution costs and for which specific products.
 - **Propagation:** Plaintiffs' experts also contend that customers using relatively more customized IRS during the Class Period would have benefitted from what I call their "Spread Propagation" theory – namely, that greater transparency and "price discipline" from AA2A-traded standardized IRS would have caused spread compression on customized IRS that continued to trade outside of AA2A platforms in the but-for world.
 - Plaintiffs' and their experts' criticisms of my opinions regarding Spread Propagation are largely a semantic disagreement about terminology and do not address the merits of my opinions. Profs. Grinblatt and Duffie also fail to recognize the theoretical and empirical basis for my opinion that many traders of less standardized IRS that would have remained off AA2A venues in the but-for world would have been harmed due to the liquidity fragmentation that would likely have occurred as a result of the introduction of AA2A trading.
- **Prof. Grinblatt's Arithmetic Compression Approach to Damages Estimation.** In his opening report, Prof. Grinblatt indicated that he would use "arithmetic compression" (*i.e.*, his

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assumption that the basis point compression in spreads for on-SEF, cleared IRS would be the same for IRS that were traded off-SEF and/or that were uncleared during the Class Period) in order to assess harm and estimate damages of putative Class Members that traded cleared IRS off-SEF and/or uncleared IRS during the Class Period.

- In my Opening Report, I noted the flaws with Prof. Grinblatt's arithmetic compression assumption for damages calculation. For example, the spread compression Prof. Grinblatt projects using his arithmetic compression theory is inconsistent with his own proposed damages model. In the Grinblatt Report, even Prof. Grinblatt's own model estimates resulted in hypothetical "actual world" spreads that were sometimes lower and sometimes higher – but by no means equivalent to – spreads on the on-SEF, cleared IRS that Prof. Grinblatt proposes as his basis for estimating damages on other IRS transactions.
- In his Reply Report, Prof. Grinblatt spends very little time defending the approach he proposed in his opening report and merely indicates that his new model demonstrates that his arithmetic compression proposal leads to consistent spread compression estimates for on- and off-SEF and cleared/uncleared IRS. But his assertions are demonstrably incorrect.
- Based on the exemplar transactions that Prof. Grinblatt presented in his opening report, the revised methodology he presents in his Reply Report once again still generates results that are inconsistent with and contrary to his proposed arithmetic spread propagation adjustment for off-SEF/cleared and any uncleared IRS during the Class Period.

B. Qualifications and Materials Relied Upon

4. I summarized my qualifications in Section I.A of my Opening Report, and Appendix A of that report presented my curriculum vitae ("CV") as of the filing date of that report. My current CV is attached here as Appendix A, which is generally unchanged.

5. I am being compensated for my time on this matter at the rate of \$1,300 per hour. My colleagues at Compass Lexecon have assisted me in the preparation of this report and are being billed at their customary hourly rates.¹² Neither my compensation nor that of Compass Lexecon is contingent upon my conclusions or the outcome of this case.

6. A list of the additional materials I have relied on in reaching my conclusions in this report is attached hereto as Appendix B.¹³

¹² I directed and supervised all of the work performed by Compass Lexecon personnel on my behalf in this matter.

¹³ Appendix B to this report only includes new materials on which I relied for this report.

HIGHLY CONFIDENTIAL**II. POTENTIAL SUITABILITY OF IRS PRODUCTS FOR AA2A EXECUTION**

7. In my Opening Report, I addressed the question of what IRS were “suitable” for AA2A execution, which the Court defined in terms of sufficient standardization and liquidity.¹⁴ Neither of Plaintiffs’ experts directly addressed this issue in their opening reports. I concluded in my Opening Report that the vast majority of IRS are not suitable for AA2A trading. Many IRS are highly customized, and only a small subset of IRS trade with a frequency that potentially would be consistent with their efficient execution on an AA2A basis.

8. Plaintiffs’ experts agree that two preconditions for IRS products to benefit from AA2A execution are sufficient standardization and liquidity.¹⁵ They further concede that certain products are unsuitable for AA2A trading because they do not satisfy one or both of these requirements.¹⁶ Nevertheless, Plaintiffs’ experts do not propose any methodology for determining what level of standardization is necessary or how much liquidity is required to support AA2A trading.

9. In my Opening Report, I demonstrated that the only IRS that might be sufficiently standardized to be suitable for AA2A trading are certain IRS with whole-year tenors. I then evaluated which of those sufficiently standardized IRS had enough liquidity to be potentially suitable for AA2A trading and concluded that only three specific IRS (USD-denominated fixed/floating IRS with two-, five-, and ten-year tenors) were potentially suitable for AA2A trading. Prof. Duffie appeared to adopt a similar perspective in his opening report and deposition, referring to certain “benchmark” IRS as suitable for AA2A trading, but his and Prof. Grinblatt’s Reply Reports now seem to disagree with my conclusions.

10. In this section, I demonstrate that Profs. Duffie’s and Grinblatt’s criticisms of my analysis of the IRS products potentially suitable for AA2A trading are flawed and unreliable.

¹⁴ MTD Opinion & Order, *op. cit.*, at fn41. Unless otherwise explicitly noted, all subsequent uses of the terms “suitable” or “suitability” refer to the context articulated by the Court.

¹⁵ See, e.g., Duffie Report, *op. cit.*, at ¶¶191, 216, & 233, Duffie Reply Report, *op. cit.*, at ¶¶62, 249 and 262, Grinblatt Report, *op. cit.*, at ¶¶140 & 180, and Grinblatt Reply Report, *op. cit.*, at ¶¶13 & 60. See also D. Duffie, “Futurization of Swaps,” *Bloomberg Government* (January 28, 2013).

¹⁶ See, e.g., Duffie Report, *op. cit.*, at ¶¶191, 222, 226, & 235, Duffie Reply Report, *op. cit.*, at ¶¶62, 249, & 262, Grinblatt Report, *op. cit.*, at ¶¶140, 180, & 266, and Grinblatt Reply Report, *op. cit.*, at ¶¶13 & 60.

HIGHLY CONFIDENTIAL**A. Standardization**

11. Prof. Grinblatt asserts in his Reply Report that he presented a common “methodology for determining on a class-wide basis which products would have traded on AA2A platforms in the but-for world....”¹⁷ But in neither his opening nor reply reports did Prof. Grinblatt identify any such methodology. In fact, Prof. Grinblatt concedes that he has not identified “individual contracts that would migrate to AA2A platforms.”¹⁸ To the contrary, his Reply Report suggests that to assess suitability he would examine if “a swap traded on an electronic platform in the actual world.”¹⁹ But a swap is not suitable for AA2A trading merely because there has been a single trade conducted on any form of electronic platform – including any form of non-anonymous or non-all-to-all execution mechanisms, such as RFQ.

12. Prof. Grinblatt also suggests that standardization could be analyzed using a set of “contractual, economic attributes that are objective and readily specified.”²⁰ Although Prof. Grinblatt does not fully specify how he would determine which IRS are sufficiently standardized to be potentially suitable for AA2A trading (and/or clearing by a central counterparty (“CCP”)), his Reply Report makes clear that many IRS *are not* suitable for AA2A trading. The characteristics identified by Prof. Grinblatt for determining whether an IRS is sufficiently standardized for AA2A trading immediately exclude many IRS traded during the Class Period.²¹

13. Specifically, Prof. Grinblatt asserts that an IRS “could have traded on AA2A platforms” if it had certain “contractual, economic attributes.”²² Table II-1 below shows the

¹⁷ Grinblatt Reply Report, *op. cit.*, at ¶141.

¹⁸ Specifically, Prof. Grinblatt states: “If it were deemed necessary that I identify individual contracts that would migrate to AA2A platforms, I would look to the attributes of the population of swaps that traded on electronic platforms in the United States.” (Grinblatt Reply Report, *op. cit.*, at ¶143) From this statement, I conclude that he has not identified any such individual contracts to date.

¹⁹ Grinblatt Reply Report, *op. cit.*, at ¶143.

²⁰ Grinblatt Reply Report, *op. cit.*, at ¶142.

²¹ Grinblatt Reply Report, *op. cit.*, at fn184.

²² Grinblatt Reply Report, *op. cit.*, at ¶142 and fn184. The specific characteristics that Prof. Grinblatt indicates are commensurate with suitable standardization for AA2A execution are as follows: (i) notional amounts denominated in a major currency; (ii) floating reference rate common to the notional currency; (iii) fixed notional principal amount; (iv) quarterly, semi-annual, or annual fixed-rate payment frequency; (v) 30/360, actual/360 (“A/360”), or A/365 day-count convention for fixed-rate payment calculations; (vi) quarterly, semi-annual, or annual floating-rate payment frequency; (vii) 30/360, A/360, or A/365 day-count convention for floating-rate payment calculations; (viii) whole integer tenor of up to 30 years or based on IMM dates; and (ix) start-date convention of spot starting,

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average daily number of trades and average daily notional amounts traded of fixed/floating IRS that exhibited Prof. Grinblatt's attributes for sufficient standardization from February 15, 2014, through December 31, 2017.²³

14. The first column of Table II-1 identifies the seven most common currencies for IRS during this period. Those seven currencies accounted for 79.6 percent of the average number of fixed/floating IRS trades and 88.2 percent of notional amounts traded across all reported currencies during the period. The second and third columns present the average daily number of trades and average daily notional amounts traded (respectively) for fixed/floating IRS that meet Prof. Grinblatt's sufficient standardization criteria. The last two columns indicate the percentage of those trades and notional amounts for each currency that meet his standardization criteria as percentages of fixed/floating IRS denominated in the various currencies indicated.

Table II-1: Average Daily Number of Trades and Average Daily Notional Amounts of Fixed/Floating IRS Potentially Suitable for AA2A Execution Based on Prof. Grinblatt's Standardization Criteria (\$mns), February 15, 2014 – December 31, 2017

Currency Denomination	Grinblatt Standardization Criteria^a		% of Total by Currency^b	
	Avg Daily # of Trades	Avg Daily Notional Traded	Avg Daily # of Trades	Avg Daily Notional Traded
AUD	37.30	\$2,195.41	62%	52%
CAD	53.92	\$3,572.70	53%	48%
CHF	6.78	\$362.62	48%	42%
EUR	162.95	\$11,073.63	54%	45%
GBP	76.27	\$4,708.82	57%	47%
JPY	59.54	\$4,149.66	61%	57%
USD	819.46	\$58,691.89	68%	64%

SOURCE: Clarus SDRView NOTES: ^a: Floating reference rate common to currency (e.g., IBORs); fixed notional amount; quarterly, semi-annual, or annual fixed- and floating-rate payment frequencies; 30/360, A/360, or A/365 fixed- and floating-rate day-count conventions; whole integer tenor of up to 30 years or based on IMM dates; and spot starting, forward starting on an IMM date, forward starting on a date one to 23 whole integer months or annually thereafter, or short forward starting effective dates. I maintain Prof. Grinblatt's definitions of swap start-date conventions for purposes of this Table – *i.e.*, “spot starting” refers to swaps with effective dates within five or fewer calendar days of the trade date, and “short forward starting effective dates” refers to swaps with effective dates between six and 30 calendar days following the trade date. See Grinblatt Report, *op. cit.*, ¶¶61-62 & 66, fn37, fn38, & fn39. ^b: Percentage of total is calculated separately for each currency denomination across all fixed/floating IRS executed during the period.

forward starting on an IMM date, forward starting on a date one to 23 whole integer months or annually thereafter, or “a short, forward starting effective date.” See also Grinblatt Report, *op. cit.*, at ¶¶61-62, 66; fn37, fn38, & fn39.

²³ This analysis is based on single currency IRS executed between February 15, 2014, through December 31, 2017, and data from Clarus Financial Technology that utilizes CFTC Part 43 reported variables. Clarus Financial Technology (“Clarus”) data consists of two separate data sets referred to as the Swap Data Repository (“SDR”) or SDRView dataset and the SEFView dataset. I used the Clarus SDRView data in this analysis. See <https://www.clarusft.com/press-releases/clarus-financial-technology-launches-sdr-view-for-swap-data-repositories/>. Clarus examined Part 43 submissions to SDRs and identified (and excluded) non-price-forming compression and list transactions, and I rely on those Clarus classifications in this analysis. I do not rely on any other algorithmic or derived transaction data Clarus adds to the Part 43 variables in Clarus SDRView.

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15. As Table II-1 indicates, even applying the overbroad set of attributes identified by Prof. Grinblatt eliminates a substantial proportion of fixed/floating IRS in each of the seven major currencies. For example, in USD-denominated IRS, only about 64 percent of IRS trades (in terms of average notional volume per day) would have been classified as USD-denominated IRS with sufficient standardization terms (according to Prof. Grinblatt) for AA2A execution during the Class Period. Across all non-dollar currencies, only about 42 to 57 percent of all average daily notional amounts traded comported with Prof. Grinblatt's standardization criteria during the Class Period.

B. Liquidity

16. Plaintiffs' experts and I also agree that another necessary (but not sufficient) condition for an IRS product to be suitable for AA2A trading is an adequate liquidity pool.²⁴ Also recognizing the importance of liquidity, the Court's motion to dismiss decision directed the parties to give "due attention" to how much liquidity – *i.e.*, "the necessary number of like-termed bids or offers pending during a given time period" – is necessary to make an IRS product suitable for AA2A trading.²⁵

(1) Liquidity and Product Heterogeneity

17. As I explained in my Opening Report, the unique characteristics of IRS (including the significant diversity of IRS products and their inherent lack of fungibility) means that demand – and, hence, trading activity – is relatively sporadic, even for the most liquid IRS products.²⁶ Thus, when compared to many other financial markets, most IRS trade relatively infrequently and in relatively large notional amounts per trade. This makes all but perhaps the most liquid benchmark-maturity IRS unsuitable for AA2A execution.²⁷ Even Prof. Duffie suggests that nothing beyond a few benchmark IRS products were potentially suitable for AA2A execution.²⁸

²⁴ See Duffie Report, *op. cit.*, at ¶41, and Grinblatt Report, *op. cit.*, at ¶146.

²⁵ MTD Opinion & Order, *op. cit.*, at fn41.

²⁶ Culp Report, *op. cit.*, at ¶¶141-142.

²⁷ Culp Report, *op. cit.*, at ¶415 (discussing how 86 percent of trades executed by one of the Named Plaintiffs were "off-market" swaps).

²⁸ Duffie Report, *op. cit.*, at ¶¶54 & 58.

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And Plaintiffs' experts do not identify *any* products that trade successfully on CLOBs in the low volumes characterized by IRS. Data showing wider spreads on IRS executed on CLOBs in the actual world supports these conclusions.^{29,30}

18. In his Reply Report, Prof. Grinblatt contends that many of the unique features of IRS products that I discussed in my Opening Report reflect only minor differences from IRS that are standardized.³¹ To support his opinion, Prof. Grinblatt analyzed how a small change from a five- or ten-year whole tenor impacts the par fixed rates on IRS as well as their *DV01s* (*i.e.*, the dollar sensitivities of a one basis point change in rates on the net present value of the swap). Specifically, Prof. Grinblatt analyzed the sensitivity of fixed/floating USD-denominated five- and ten-year IRS with \$10mn and \$40mn notional amounts to changes in IRS tenors from whole-year five- and ten-year maturities by ± 1 to ± 15 days. Prof. Grinblatt concludes that the differences among such products is minor.³²

19. Prof. Grinblatt, however, makes no attempt to substantiate how distinct buy-side customers and putative Class Members might perceive these differences among the IRS that he examines in his Reply Report (much less how potentially disparate customers might view differences in fixed rates or *DV01s* for IRS with larger notional amounts). Even more importantly, Prof. Grinblatt seems to presume that putative buy-side Class Members are using IRS only to manage their *DV01* interest rate risks (either as hedgers or speculators)³³ when, in fact, hedgers using IRS often have other hedge objectives.

20. In particular, Prof. Grinblatt fails to recognize that *why* a firm hedges affects *how* a firm hedges and that *DV01s* and initial par fixed rates are not always the primary consideration of

²⁹ See Culp Report, *op. cit.*, at Table III-6.

³⁰ To the extent that there was trading of IRS on CLOBs during the Class Period, such trading occurred on D2D platforms. Because Plaintiffs have not alleged any conspiracy of dealers against each other, Plaintiffs have no basis to argue that the D2D CLOB data during the Class Period cannot be relied upon due to the existence of the alleged conspiracy.

³¹ Culp Report, *op. cit.*, at ¶¶132-138, and Grinblatt Reply Report, *op. cit.*, at ¶¶209-210.

³² Grinblatt Reply Report, *op. cit.*, at ¶213 and Table IV.7.

³³ See, *e.g.*, Grinblatt Report, *op. cit.*, at ¶¶206, 208, 264-265, and 297.

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buy-side hedgers.³⁴ End users of derivatives that are seeking to hedge existing risk exposures typically fall into one of three categories (which are generally mutually exclusive): (i) “value hedgers” seek to manage the risk of periodic changes in the net asset/liability value of hedges and exposures to be hedged (including firms that try and match the *DV01s* of their hedge positions with *DV01s* of exposures to be hedged); (ii) “cash flow hedgers” seek to minimize their net cash flow volatility by matching as closely as possible the exact settlement dates and terms of their interest-sensitive assets and liabilities; and (iii) “earnings hedgers” primarily seek to minimize the volatility of stated accounting earnings.³⁵

21. The sensitivity analysis that Prof. Grinblatt presents in Table IV.7 of his Reply Report is based on the levels of fixed par swap rates and IRS *DV01s*. He thus implicitly presupposes that IRS users are *value* hedgers and not *cash flow* or *earnings* hedgers. *Cash flow and/or earnings* hedgers typically will be much more focused on the exact matching of cash flows on assets and liabilities and care very much about even a small mismatch of a few days between a risk exposure and an IRS used to hedge that exposure. Ultimately, the only way to assess with any reliability whether differences between IRS products would be considered to be economically significant by buy-side hedgers is through individualized inquiries.³⁶

(2) Empirical Analysis of Sufficient Liquidity

22. In my Opening Report I set forth an empirical test to determine the minimum volume of liquidity required for an IRS product to be suitable for AA2A trading in the but-for world. To my knowledge, my test represents the only effort in this case to answer the Court’s suitability question through empirical, quantitative analysis.

³⁴ C. L. Culp and M. H. Miller, “Introduction: *Why a Firm hedges Affects How a Firm Hedges*,” in C. L. Culp and M. H. Miller, eds., *Corporate Hedging in Theory and Practice* (London: Risk Books, 1999), and the references cited therein.

³⁵ See, e.g., J. C. Lewent and A. J. Kearny, “Identifying, Measuring, and hedging Currency Risk at Merck,” *Journal of Applied Corporate Finance* Vol. 2, No. 4 (Winter 1990), and K. A. Froot, D. S. Scharfstein, and J. C. Stein, “Risk Management: Coordinating Corporate Investment and Financing Decisions,” *Journal of Finance* Vol. 48, No. 5 (December 1993). See also C. L. Culp, *The Risk Management Process* (Hoboken, N.J.: John Wiley & Sons, 2001), at 188-201.

³⁶ See the related discussion in Section IV.A. That Prof. Grinblatt focuses his reply to my Opening Report on *DV01*-based value hedges to the exclusion of cash flow or earnings hedges is a further indication of why his opinions are unreliable and cannot be generalized on a common Class-wide basis. Individualized inquiries are essential to ascertain the hedging objectives – and hence tolerance for basis risk – of putative Class Members.

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23. Plaintiffs and Plaintiffs' experts criticize my minimum liquidity test along several dimensions. All their criticisms reflect a misunderstanding of the rationale and/or the mechanics of the test and are fundamentally flawed.

a) Foundations of My Liquidity Test in the Academic Literature

24. Contrary to Plaintiffs' assertions, I began by surveying the academic literature and found no specific examples of an appropriate, quantitative liquidity test to determine suitability for AA2A execution of any particular financial instrument where AA2A execution had not previously existed. I therefore developed a test based on well-accepted empirical methods and principles used in the financial economics academic literature.

25. First, my test utilizes a "comparables" approach, which uses data from comparable financial asset markets to draw inferences about an asset for which certain variables like price, volume, and spreads are non-existent or unobservable. The use of comparables in academic financial economics and in financial practice is well-established. Some common uses of comparables in the academic literature are as follows:

- *Financial Instrument or Exposure Valuation:* When trying to estimate the theoretical value/price of a target financial asset (e.g., a share of common stock issued by a firm), academics undertake approaches that rely on the values of a comparable financial asset or exposure:
 - "No-arbitrage" valuation approaches are used to estimate the theoretical value of target financial assets whose cash flows can be exactly replicated with existing traded assets or portfolios that mimic macroeconomic risk factors.³⁷

³⁷ See, e.g., F. Modigliani and M. H. Miller, "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review* Vol. 48, No. 3 (1958), E. F. Fama and M. H. Miller, *The Theory of Finance* (New York, N.Y.: Holt, Rinehart, and Winston, 1972), F. Black and M. Scholes "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy* Vol. 81 (1973), R. C. Merton, "Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science* Vol. 4, No. 1 (Spring 1973), R. C. Merton, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance* Vol. 29, No. 2 (May 1974), and S. A. Ross, "The Arbitrage Theory of Capital Asset Pricing," *Journal of Economic Theory* Vol. 13 (1976). See also C. L. Culp and J. H. Cochrane, "Equilibrium Asset Pricing and Discount Factors: Overview and Implications for Derivatives Valuation and Risk Management," in *Modern Risk Management: A History*, P. Field, ed. (London: Risk Books, 2003).

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- “Near-arbitrage” valuation involves the use of close but imperfect substitutes (in terms of cash flows and changes in values) as the basis for valuing a target instrument when the cash flows on the target asset cannot be exactly replicated.³⁸
- *Performance Evaluation*: A widespread application of comparables and benchmarks in the financial economics literature involves the comparison of return and risk attributes of assets/portfolios to comparable assets/portfolios for the purpose of evaluating the investment performance of the target asset/portfolio.³⁹
- *Mergers & Acquisitions*: Academics (and courts) commonly assess the appropriate value of a highly leveraged transaction (e.g., merger or an acquisition) based on the identification of a comparable highly leveraged transaction.⁴⁰

In keeping with this published academic literature, I identified Eurodollar futures as the most appropriate comparable AA2A-traded product to fixed/floating IRS because Eurodollar futures are the most actively traded and liquid futures contract in the world and have a subset of transactions that are economically equivalent to a subset of USD fixed/floating IRS. Many of the latter have values on their settlement dates based on 3mLIBOR, which is the underlying reference rate for Eurodollar futures settlements.⁴¹

26. Prof. Grinblatt also relies on a comparables approach to arrive at his 80 percent spread compression estimate. As he explains: “I studied other financial markets, and specifically, the effects on bid-ask spreads of other financial instruments when these markets underwent a comparable transition in market structure.”⁴² The benchmarks included Treasuries, West Texas

³⁸ See, e.g., S. A. Ross, “Hedging Long-Run Commitments: Exercises in Incomplete Market Pricing,” *Economic Notes – Economic Review of Banca Monte dei Paschi di Siena* Vol. 26, No. 2 (1997), reprinted from C. L. Culp and M. H. Miller, eds., *Corporate Hedging in Theory and Practice* (London: Risk Books, 1993), A. E. Bernardo and O. Ledoit, “Gain, Loss, and Asset Pricing,” *Journal of Political Economy* Vol. 108 (2000), and J. H. Cochrane and J. Saá-Requejo, “Good Deal Asset Price Bounds in Incomplete Markets,” *Journal of Political Economy* Vol. 108 (2000).

³⁹ See, e.g., W. F. Sharpe, “Asset Allocation: Management Style and Performance,” *Journal of Portfolio Analysis* (Winter 1992), M. Grinblatt and S. Titman, “Performance Evaluation,” in *Handbooks in Operations Research and Management Science*, R. Jarrow et. al., eds. (Amsterdam: Elsevier Science, 1995), K. Chan, S. G. Dimmock, and J. Lakonishok, “Benchmarking Money Manager Performance: Issues and Evidence,” *Review of Financial Studies* Vol. 22, No. 11 (2009), and J. Christopherson, D. R. Cariño, and W. E. Ferson, *Portfolio Performance Measurement and Benchmarking* (New York, N.Y.: McGraw-Hill, 2009), at 261-221.

⁴⁰ See, e.g., R. F. Bruner, *Applied Mergers and Acquisitions* (Hoboken, N.J.: John Wiley & Sons, 2004), at 260, J. Rosenbaum and J. Pearl, *Investment Banking: Valuation, Leverage Buyouts, and Mergers & Acquisitions*, 2nd ed. (Hoboken, N. J.: Wiley, 2013), at 83-124, and D. M. DePamphilis, *Mergers Acquisitions, and Other Restructuring Activities: An Integrated Approach to Process, Tools, Cases, and Solutions*, 9th ed. (London: Academic Press, Elsevier, 2018), at 280-311.

⁴¹ Culp Report, *op. cit.*, at ¶¶162, & 171-172.

⁴² Grinblatt Reply Report, *op. cit.* at ¶273.

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Intermediate-grade crude oil futures, and dividend swaps markets.⁴³ I disagree with Prof. Grinblatt's choice of benchmarks because they are economically far less similar to IRS than the Eurodollar futures contract that I used in my liquidity test.

27. Second, having chosen Eurodollar futures as the most relevant comparable, I relied upon the well-established empirical relationship between volume and bid-ask spreads to design a comparison to see if specific IRS are suitable for AA2A execution.⁴⁴ Specifically, I identified an Upper Minimum Liquidity Bound based on the Eurodollar futures contract with the lowest average daily notional volume that exhibits a median best bid-ask spread equivalent to the CME's specified minimum tick size, and I identified a Lower Minimum Liquidity Bound based on the Eurodollar futures contract with the highest average daily notional volume whose median best bid-ask spread exceeded the minimum tick size.⁴⁵

28. Third, I used trading volume – a well-recognized proxy for liquidity – to measure the liquidity of the IRS market.⁴⁶ Specifically, I compared the average daily number of trades and average daily notional amounts traded of the Eurodollar futures contracts at the Upper and Lower Minimum Liquidity Bounds to the fixed/floating IRS universe. This comparison allowed me to ascertain whether liquidity for a given IRS tenor was commensurate with liquidity in the corresponding Eurodollar futures contract that had spreads equal to the futures contract's minimum tick size. In other words, the comparison evaluates whether the spread would have been sufficient to entice customers to migrate from the execution mechanisms they were previously using to an AA2A platform.

⁴³ Grinblatt Reply Report, *op. cit.* at ¶274.

⁴⁴ Articles in the academic literature that substantiate an empirical inverse relation between trading volume and bid-ask spreads include, for example, H. Demsetz, "The Cost of Transacting," *Quarterly Journal of Economics* Vol. 82, No. 1 (1968), T. E. Copeland and D. Galai, "Information Effects on the Bid-Ask Spread," *Journal of Finance* Vol. 38 (1983), and Y. Amihud and H. Mendelson, "Asset Pricing and the Bid-Ask Spread," *Journal of Financial Economics* Vol. 17 (1986).

⁴⁵ Culp Report, *op. cit.*, at ¶¶175, 180, & 184.

⁴⁶ The use of trading volume as a proxy for market liquidity is widely used by academics and practitioners. *See, e.g.*, M. Pagano, "Trading Volume and Asset Liquidity," *Quarterly Journal of Economics* Vol. 104, No. 2 (May 1989). CME's periodic report on the liquidity of its interest rate futures uses average daily volume of interest rate futures as a metric for liquidity, along with percentage of trades at the minimum price increment, depth of book, open interest, and breadth of market participation. *See* <https://www.cmegroup.com/education/featured-reports/interest-rate-futures-liquidity-update.html>.

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29. Applying this test, I found that at most three types of IRS would have been potentially suitable for AA2A execution during the Class Period – *i.e.*, fixed/floating IRS with two-, five-, and ten-year tenors.⁴⁷

b) Prof. Grinblatt's Proposed Volume Adjustment

30. Plaintiffs and Prof. Grinblatt contend that to perform my test, IRS volumes would need to be adjusted before comparing them to individual Eurodollar futures contract volumes, and that my analysis is supposedly “flawed” because I did not perform this adjustment. Prof. Grinblatt proposes to correct the supposed error in my analysis by adjusting IRS volumes according to the number of futures contracts he believes would be in a corresponding Eurodollar futures strip with the same tenor. Prof. Grinblatt’s criticism of my approach is misplaced.

31. Specifically, Prof. Grinblatt’s criticism and his proposed adjustment reflects his conflation of my rationale for choosing the appropriate comparable asset in my liquidity test with the mechanical implementation of my test itself. As discussed earlier in Section II.B(2)(a), the foundation of my liquidity test is the use of comparable assets and markets. Such analyses can broadly be separated into two distinct stages: (i) identification of the appropriate comparable asset or transaction that will serve as the basis for comparison with the target asset or transaction to be analyzed; and (ii) design of a specific comparison test involving the chosen comparable asset or transaction and the target.

32. My two-stage approach is standard in a comparables analysis in the relevant academic literature. For example, in a corporate valuation or M&A context, at the first stage, in order to select the focus of the comparison, it is common to consider, among other things, the target company’s industry, size, geography and structure. At the second stage, the comparison metric is not based on factors that led to the selection of the comparable but instead is focused on the reason for the comparison, and in the valuation context often is based on different factors such as earnings or market capitalization ratio.

33. In terms of my stage (i) selection of the appropriate comparable asset to IRS, I selected Eurodollar futures because they are the largest and most liquid futures market in the world *and*

⁴⁷ Culp Report, *op. cit.*, at ¶188 and Table III-8.

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because a subset of Eurodollar futures transactions (*i.e.*, Eurodollar futures strips) is economically equivalent to a subset of fixed/floating cleared IRS. The economic comparability of Eurodollar futures strips and certain fixed/floating IRS represents a common economic linkage between these two markets but does *not* provide a direct side-by-side basis for comparison of the broader IRS market to the more limited Eurodollar strip universe.

34. Having chosen Eurodollar futures as the relevant comparable asset in stage (i), I then turned to stage (ii) of my test to implement my actual, direct liquidity comparison. This did *not* necessitate a direct comparison of Eurodollar strips, packs, or bundles to comparable IRS. The relevant question in stage (ii) was simply: For a given target asset (IRS) identified as comparable to a different asset (Eurodollar futures), what is the minimum liquidity required to sustain AA2A trading in the target IRS asset? As I explained in my Opening Report and again in my deposition, answering this question required a direct comparison of *individual* Eurodollar futures to IRS.

35. The criticism advanced by Prof. Grinblatt in his Reply Report that I should have compared IRS trading to Eurodollar strip volumes makes no sense, moreover, because a Eurodollar strip is not an individually listed product that can be traded on its own.⁴⁸ Eurodollar strips with an economic equivalence to a fixed/floating IRS are constructed by transacting a series of individual constituent Eurodollar futures contracts. There thus is no such thing as a unique liquidity pool and a single bid-ask spread of Eurodollar strips. Even at the clearing stage, Eurodollar strips are not recognized or tracked as separate products. For example, a strip in which a trader has one long position in each of the MAR20, JUN20, SEP20, and DEC20 Eurodollar futures contracts is not seen by CME Clearing as one strip, but rather as just four distinct contracts with one long position in each, consistent with the way the contracts were purchased.

36. Plaintiffs claim that adding a multiplier to IRS notional volumes allows for an “apples-to-apples comparison” between IRS and Eurodollar futures. Prof Grinblatt provides no justification for this exercise, and there is none. My test looks at actual products (Eurodollar futures) that are traded on an AA2A exchange, determines the volume of trading required for the

⁴⁸ As I testified at my deposition, I did initially consider doing a strip-to-IRS direct comparison, but I rejected that approach, because, as I explain in this discussion, doing so makes no sense. (Deposition of Christopher L. Culp, Ph. D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (August 29, 2019) (hereinafter “Culp Dep. Tr.”), at 287:18-290:23.)

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product to be liquid in AA2A trading, and then compares that volume against the volume of IRS to determine which IRS are sufficiently liquid. Prof. Grinblatt arbitrarily compares the Eurodollar volume traded to a *multiple* of the volume of IRS actually traded. For example, although the 7-year IRS traded on average \$1,033.5 million per day, Prof. Grinblatt multiplies the actual volume by 28 and then treats \$28,938.18 million per day as the average notional volume. But the 7-year IRS does not trade anywhere close to \$28,938.18 million per day, and there is no basis for simply assuming that it has the same liquidity as any product that trades \$1,033.5 million per day. The correct test is the one I applied: comparing the actual trading volumes of products that are actually traded.

37. As a further indication that Prof. Grinblatt's volume adjustment makes no sense, consider 30-year IRS. First, CME does not list Eurodollar futures beyond 10 years to maturity, so Prof. Grinblatt's adjustment is based on hypothetical Eurodollar futures that do not actually exist. Second, when Prof. Grinblatt's proposed adjustment is applied, 30-year IRS appear substantially more liquid than two- and five-year swaps, whereas three-months swaps – the only tenor to which a multiplier was not applied – are the only ones that appear unsuitable for AA2A trading.⁴⁹ But it is well-accepted that 30-year swaps are substantially *less* liquid than two-year or five-year IRS. Prof. Grinblatt's approach would thus lead to the (incorrect) conclusion that IRS with longer tenors are more suitable for exchange trading simply because more Eurodollar futures contracts are hypothetically required to create an economically equivalent strip.

c) Eurodollar Futures Trading at CME's Minimum Tick Size

38. Related to the discussion in the previous section, Plaintiffs' experts contend that my analysis of best bid and offer spreads on Eurodollar futures as a criterion for fully liquid contracts is not meaningful. Prof. Grinblatt states that, "The effective cost of trading on these CLOBs is substantially less than the minimum tick size as evidenced by research that shows that over 40 percent of trades in Eurodollar futures trades occur 'at the mid' by filling half the trade volume at the bid and half at the ask or through 'workup' trading protocols that allow buyers and

⁴⁹ Grinblatt Reply Report, *op cit.* at ¶ 221.

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sellers to match their orders at zero effective bid-offer spread.”⁵⁰ Prof. Duffie cites the same study by Greenwich Associates to make a similar argument.⁵¹ Profs. Duffie and Grinblatt, however, err in their reliance on the Greenwich Associates survey.⁵²

39. The Greenwich Associates survey does not support the proposition that Eurodollar futures trades can occur at prices below the minimum tick size because (i) the report covers more than Eurodollar futures, and there is no indication that the conclusion applies to Eurodollar futures; (ii) for most Eurodollar futures, execution at the mid is *impossible*; and (iii) the workup mechanism on which they rely doesn’t exist for Eurodollar futures.

40. First, the Greenwich Associates survey is based on a sample of “various interest rate futures products.”⁵³ The interest rate futures examined in the Greenwich Associates study are not limited to Eurodollar futures, and there is no basis for assuming that any particular finding applies to Eurodollar futures. Even with respect to Eurodollar futures, Greenwich Associates did not confine its survey to contracts with median best bid-offer spreads equal to CME’s minimum tick size. Deferred maturity contracts for which the best bid-ask spread was in excess of the CME-defined minimum tick size (as shown in Exhibit III-3 of my Opening Report) can trade inside the bid-ask spread, but those contracts did not play a role in my Opening Report, which analyzed spreads for contracts in which the best spread equaled the minimum tick size.

41. Second, as I indicated in my Opening Report and my deposition testimony, it is impossible *as an operational matter* for Eurodollar futures transactions to be executed within the best bid and offer *for a contract with spreads equal to the CME’s defined minimum tick size*. For relatively less liquid Eurodollar futures contracts with longer-dated maturities with best bid-ask

⁵⁰ Grinblatt Reply Report, *op. cit.*, at ¶208.

⁵¹ Duffie Reply Report, *op. cit.*, at ¶52.

⁵² Plaintiffs are highly critical of the survey that I supervised for ISDA of 295 buy-side customers (discussed in my Opening Report, *op. cit.*, at ¶¶75-78) – *see Memorandum of Law in Support of Plaintiffs’ Motion to Exclude the Expert Report and Testimony of Dr. Christopher L. Culp, In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (October 1, 2019) (hereinafter “Ptfs MOL ISO Culp Exclusion”), at 21-22. (Plaintiffs mischaracterize my deposition testimony by saying that I “did not review the underlying data before relying on it,” which is false.) Nevertheless, Plaintiffs and their experts rely heavily on a survey conducted by Greenwich Associates in which Plaintiffs and their experts had no role and apparently lack sufficient familiarity with the underlying data to substantiate their inferences.

⁵³ Greenwich Associates, *Total Cost Analysis of Interest-Rate Swaps vs. Futures* (2015), at 4.

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spreads in excess of the 0.50 bps tick size, it is of course possible for executions to occur inside the prevailing best bid-ask spread. But as a matter of the CME rules, it is *impossible* for transactions to occur inside the best bid-ask spread for contracts in which the best bid-ask spread is equal to the minimum tick size. I confirmed this empirically by analyzing transaction prices compared to best bid-offer spreads for Eurodollar futures traded on the Globex platform between 2014 and 2015.⁵⁴ That analysis shows that the transaction prices are expressed as a multiple of the tick size for every traded price, and not a single trade occurred within the minimum price increment on the exchange.

42. Third, although Prof. Grinblatt contends based on the Greenwich survey that “over 40 percent of trades in Eurodollar futures trades occur ‘at the mid’ by filling half the volume at the bid and half at the ask through ‘workup’ trading protocols that allow buyers and sellers to match their orders at zero bid-offer spreads,”⁵⁵ the Greenwich survey does not discuss workup protocols for Eurodollar futures either on the page he cited or anywhere else in the study. Prof. Grinblatt supports his position with a claim that he “verified [his position]...in conversations with officials at CME’s Interest Rate Derivatives business product group.”⁵⁶ In my own discussions with senior CME personnel (including a member of CME’s C-suite), however, I was assured that Globex does not now, nor has it ever, permitted workups as a trading protocol for Eurodollar futures.

43. Plaintiffs and their experts also criticize my use of the term “fully liquid” to describe Eurodollar futures contracts for which the median best bid-ask spread is equal to the minimum tick size and contend (based on the study conducted by Greenwich Associates) that many Eurodollar futures transactions are actually executed at the midpoint within the best bid-ask spread.⁵⁷ I do not dispute that executions may occur inside the bid-ask spread *when the spread exceeds the minimum tick size* (e.g., for relatively long-dated contracts). But Plaintiffs and their

⁵⁴ The sample period ends in 2015 because I observe a shift in the structure of the CME Top of Book – BBO data starting in 2016 that render the bid-ask quoted pairs unreliable. *See Culp Report, op. cit.*, at fn172.

⁵⁵ Grinblatt Reply Report, *op. cit.*, at ¶¶208 & 216.

⁵⁶ Grinblatt Reply Report, *op. cit.*, at fn287.

⁵⁷ Ptfs MOL ISO Culp Exclusion, *op. cit.*, at 14-15, Duffie Reply Report, *op. cit.*, at ¶52, and Grinblatt Reply Report, *op. cit.*, at ¶208.

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experts' criticism is incorrect because it is simply not possible for a transaction to be executed inside the best bid-ask spread when that spread coincides with the exchange-defined minimum tick size. It is therefore reasonable for me to define a contract as "fully liquid" based on where the median spread equals one tick. Even Prof. Duffie conceded at his deposition that the tick size represents a lower bound on the best bid and offer and that price increments on a CLOB cannot be smaller than the minimum tick size.⁵⁸ (See Section III for further details.)

d) Conservativism of My Proposed Liquidity Test

44. Although Prof. Grinblatt claims that "virtually every tenor" of IRS would migrate to AA2A execution based on his supposed "correction" to my liquidity test⁵⁹ and complains that I find only three IRS tenors that meet my liquidity test,⁶⁰ it is important to highlight the conservativism of my empirical approach. Indeed, my approach was designed to be favorable for Plaintiffs and likely overestimates the IRS that are potentially suitable for AA2A trading.

45. The liquidity prong of my analysis of which IRS products are potentially suitable for AA2A trading defines two thresholds – the Upper Minimum Liquidity Bound, based on the last fully liquid contract (rank 20) and the Lower Minimum Liquidity Bound, based on the first non-fully liquid contract (rank 21).⁶¹ I consider IRS with liquidity above the Lower Minimum Liquidity Bound of \$3.2 billion in average daily notional as potentially suitable for AA2A trading.⁶² This approach is conservative and in Plaintiffs' favor in at least three respects.

46. First, I could have considered IRS suitable for AA2A trading if they had liquidity of at least that of the Upper Minimum Liquidity Bound, \$18.2 billion in average daily notional amounts.⁶³ In such a case, no IRS would have been potentially suitable for AA2A execution.⁶⁴

⁵⁸ Duffie Dep. Tr., *op. cit.*, at 169:6-15. See also Duffie Reply Report, *op. cit.*, at ¶199.

⁵⁹ Grinblatt Reply Report, *op. cit.*, at ¶221.

⁶⁰ Grinblatt Reply Report, *op. cit.*, at ¶216.

⁶¹ Culp Report, *op. cit.*, at ¶184.

⁶² Culp Report, *op. cit.*, at ¶¶185, 188.

⁶³ Culp Report, *op. cit.*, at ¶184.

⁶⁴ Culp Report, *op. cit.*, at Table III-6.

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47. Second, as I discussed in my Opening report, given that it is implausible that the minimum tick size for an AA2A CLOB in the but-for world would be below 0.5 bps, many putative Class Members would not have benefited from moving to a CLOB because the already received bid-ask spreads via RFQ were lower than 0.5 bps.⁶⁵ Thus, some of the liquidity of the IRS I identified as potentially suitable for AA2A trading may have remained on RFQ execution venues with, in consequence, less trading volume available for AA2A – perhaps enough to place some or all of those products below (or further below) the Lower Minimum Liquidity Bound.

48. Third, I based my liquidity test on the average daily notional amount traded rather than the average number of trades per day.⁶⁶ Using notional amounts rather than the number of trades in defining the Upper and Lower Minimum Liquidity Bounds adds further conservatism. Based on the average daily number of trades at CME, the Upper and Lower Minimum Liquidity Bounds could have been defined as 18,200 and 3,200 average trades per day, respectively. Even the benchmark USD-denominated fixed/floating IRS with the largest number of average trades per day (*i.e.*, the two-year benchmark IRS⁶⁷) trades only 61 times a day on average, which would be well below the 3,200 average daily volume of the rank 21 Eurodollar futures contract. Thus, use of number of trades would mean that *no* IRS would be suitable for AA2A. Nonetheless, to be conservative, I rely on average daily notional volumes in developing my empirical test.⁶⁸

49. Fourth, I looked at all IRS contracts of a given benchmark tenor, and not just contracts that had all the other properties of a benchmark, such as spot-starting dates and 3mLIBOR floating reference rates. Limiting the volumes to only spot-starting IRS referencing 3mLIBOR would have resulted in no IRS being sufficiently liquid for AA2A trading, as shown in the two right-hand columns of Table III-8 in my Opening Report, although the two-, five-, and ten-year benchmarks come somewhat close.

⁶⁵ Culp Report, *op. cit.*, at ¶195.

⁶⁶ Culp Report, *op. cit.*, at ¶¶182-183.

⁶⁷ Culp Report, *op. cit.*, at Table III-8, Column 4.

⁶⁸ As I previously explained, dissection of larger notional IRS into smaller standardized AA2A-listed IRS would have been unlikely, in part because of increased clearing costs. *See* Culp Report, *op. cit.*, at ¶¶182-183.

HIGHLY CONFIDENTIAL*e) IRS Trading Volume in Plaintiffs' But-For World and the Role of HFTs and PFTs*

50. In my liquidity test, I made a neutral assumption that IRS trading volumes in the but-for world would neither grow nor shrink relative to actual-world volumes. By contrast, Plaintiffs' experts surmise that aggregate trading volumes in the but-for world would have increased absent the alleged conspiracy.⁶⁹ But as I explained in my Opening Report, IRS are used by firms mainly to hedge specific risks or to increase their exposure to interest rates using targeted trading strategies.⁷⁰ The majority of buy-side swap trading can be attributed to the natural demand from hedgers or speculators. Plaintiffs have not provided any evidence of increased demand or usage from such buy-side customers and also have not demonstrated an increased usage of IRS from dealers in the but-for world.⁷¹

51. Plaintiffs' experts opine that high-frequency traders ("HFTs") and principal trading firms ("PTFs") would have been a strong additional source of IRS liquidity in the but-for world and were deterred from doing so because of the alleged conspiracy.⁷² In my Opening Report, I explained that CFTC regulations provided a significant barrier to entry for HFTs and PTFs as IRS liquidity providers.⁷³ Specifically, the so-called "Floor Trader Exclusion"⁷⁴ to the CFTC's Swap Dealer registration requirements created significant regulatory uncertainty about the

⁶⁹ Grinblatt Report, *op. cit.* at ¶¶175-177, and Grinblatt Reply Report, *op. cit.* at ¶¶122-124.

⁷⁰ Culp Report, *op. cit.*, at ¶¶42-44.

⁷¹ For further discussion of these issues, see Johannes Report *op. cit.*, at ¶¶243-246, and Expert Reply Report of Michael Johannes, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (November 27, 2019), at ¶¶22-23.

⁷² Duffie Report, *op. cit.*, at ¶¶70, 183, & 229, and Grinblatt Reply Report, *op. cit.*, at ¶¶27 & 256-260.

⁷³ Culp Report, *op. cit.*, at ¶¶83-85. Prof. Grinblatt claims that I stated that HFTs were *prohibited* from IRS CLOB trading (Grinblatt Rebuttal Report, *op. cit.*, at ¶161), although what I actually stated was that they were *inhibited* (Culp Report, *op. cit.*, at ¶83). Under the Floor Trader Exclusion, non-bank dealers like HFTs and PTFs were permitted to provide liquidity in IRS on CLOBs operated by DCMs or SEFs in cleared, on-SEF IRS in which price and quantity were the only terms subject to negotiation and which were CLOB-executed. Specifically, firms are subject to a *de minimis* exemption to Swap Dealer registration if they engage in less than \$8 billion gross notional in IRS. Firms that had more than \$8 billion gross notional in IRS had to register as Dealers. Under the Floor Trader Exclusion, certain cleared, on-SEF, non-customized, CLOB-executed IRS were exempt from calculations of gross notional amounts as applied to Dealer registration requirements. (17 CFR §1.3 ("Swaps Entered Into by Floor Traders" and "Swap Dealer").)

⁷⁴ See, e.g., CFTC, No-Action Letter, "Time-Limited No-Action Relief: Request that Certain Swaps Not Be Considered in Calculating Aggregate Gross Notional Amount for Purposes of the Swap Dealer De Minimis Exception for Persons Engaging in Floor Trader Activities," *CFTC Letter No. 12-60* (December 19, 2012), and CFTC, No-Action Letter, "No-Action Relief from Certain Conditions of the Swap Dealer Exclusion for Registered Floor Traders," *CFTC Letter No. 13-80* (December 23, 2013).

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potential costs faced by HFTs and PTFs that registered as floor traders and provided IRS liquidity on SEFs.⁷⁵

52. Plaintiffs' experts assert that a handful of non-bank dealers expressed some *interest* during the Class Period in providing IRS liquidity. Both Profs. Duffie and Grinblatt, however, focus mainly on the interest of certain HFTs and PTFs providing liquidity in IRS SEF markets without distinguishing between firms that expressed such interest to the press or to would-be execution platforms vis-à-vis those firms that actually began providing such liquidity. In fact, most HFTs and PTFs (with the exception of Citadel) were unwilling to engage in IRS liquidity provision (either at all or in any significant amounts) because of regulatory uncertainties. As I explained in my Opening Report, in 2012 and 2013, the CFTC provided No-Action relief for "Registered Floor Traders" from the CFTC's Swap Dealer registration requirements in order to enable proprietary trading firms to become liquidity providers on SEFs.⁷⁶ In its No-Action relief (the "Floor Trader Exclusion"), however, the CFTC agreed to exempt such firms' on-SEF transactions *only if* these firms limited their trading to standardized and cleared IRS in which the only terms to be negotiated were price and quantity.⁷⁷ Most HFTs and PTFs thus declined to provide liquidity for IRS because they were not willing to register as swap dealers. The following examples demonstrate this concern:

- On June 23, 2015, the Principal Traders Group of the Futures Industry Association ("FIA PTG") (representing 20 of the largest prospective floor trader providers of IRS market making liquidity) submitted a letter to the CFTC requesting an interpretive letter clarifying some of the ambiguities in the CFTC's Floor Trader Exclusion. The letter stated:

FIA PTG member firms are interested in providing liquidity for swaps offered for trading on swap execution facilities ("SEFs") or designated contract markets

⁷⁵ One of the most significant concerns (given the vagaries of the CFTC guidance) was that non-cleared and/or off-SEF IRS with customized terms apart from price and quantity would cause *all* IRS executed by the registered floor trader (including otherwise-exempt on-SEF, cleared IRS) toward the \$8 billion *de minimis* CFTC Swap Dealer registration threshold. See, e.g., Letter from M. A. Burns (FIA PTG) to E. Flaherty (CFTC), "Request Pursuant to Commission Regulation 140.99 for No-Action Relief Regarding the Terms of the Exclusion from the Swap Dealer Determination for Certain Swaps Entered Into by a Floor Trader Under Commission Regulation 1.3(ggg)(6)(iv)" (February 10, 2016) (hereinafter "FIA PTG February 2016"), at 2, CFTC, "No-Action Relief for Certain Conditions of the Floor Trader Provision," *CFTC Letter No. 19-14 (No-Action)* (June 27, 2019) (hereinafter "CFTC No-Action Letter (June 2019)"), and J. Rennison and B. Jopson, "CFTC Head Dismisses Easing Rules to Benefit High-Speed Traders," *Financial Times* (August 18, 2016).

⁷⁶ Culp Report, *op. cit.*, at ¶84, fn79.

⁷⁷ Culp Report, *op. cit.*, at ¶84, fn80.

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(“DCMs”), but have been hesitant to do so in light of the substantial regulatory costs they would incur should such trading trigger an obligation to register as a swap dealer, and difficulty in evaluating whether the exclusion for floor trader activity...is viable due to some ambiguity as to how certain transaction-specific conditions apply.⁷⁸

- On January 27, 2016, the FIA PTG submitted a comment letter to the CFTC in which it further stated that “[u]nfortunately to date, the Floor Trader Exclusion has not generated the type of growth in exchange traded and cleared swaps that we had hoped to see.”⁷⁹
- Because the CFTC did not issue a clarification of the Floor Trader Exclusion following the FIA PTG’s June 2015 and January 2016 letters, on February 10, 2016, the FIA PTG took the further step of requesting no-action relief from the CFTC. In its request for regulatory relief, the FIA PTG once again confirmed that its concern with providing liquidity on SEFs for IRS trades was based on regulatory uncertainty and potential Dealer registration costs:

FIA PTG member firms are interested in providing liquidity for swaps offered for trading on SEFs or DCMs, but have been hesitant to do so in light of the substantial regulatory costs they would incur should such trading trigger an obligation to register as a swap dealer and the considerable uncertainty as to whether the exclusion for floor trader activity...is a viable alternative.^{80,81}

- In August 2016, then-CFTC chairman Timothy Massad remained opposed to clarifying the Floor Trader Exclusion and told the *Financial Times*: “If [HFTs and PTFs] really want to make a market in swaps they can register as swap dealers.”⁸² The *Financial Times* further reported that “[a] person close to the CFTC said that new entrants are not being blocked from challenging banks dominance, they will just have to stump up the capital required to do so. ‘They are not prevented. They are making a cost choice based on becoming a dealer.’”⁸³ Neither Prof. Duffie nor Prof. Grinblatt documented any interest or activity by HFTs or PTFs in providing IRS liquidity on SEFs after the date of CFTC Chairman Massad’s proclamation.

⁷⁸ Letter from M. A. Burns (FIA PTG) to T. Smith (CFTC DSIO), “Request Pursuant to Commission Regulation 140.99 for an Interpretive Letter Confirming the Terms of the Exclusion from the Swap Dealer Determination for Certain Swaps Entered Into by a Floor Trader Under Commission Regulation 1.3(ggg)(6)(iv)” (June 23, 2015), at 1.

⁷⁹ Comment Letter from M. A. Burns (FIA PTG) to C. J. Kirkpatrick (CFTC Secretary), “Swap Dealer De Minimus Exception Preliminary Report” (January 27, 2016), at 3.

⁸⁰ FIA PTG (February 2016), *op. cit.*, at 2.

⁸¹ In its request for no-action relief, the FIA PTG requested the CFTC to commit not to pursue enforcement actions against registered floor traders if they engaged in non-cleared and/or off-SEF IRS and/or negotiated the terms of such non-cleared/off-SEF swaps apart from price and quantity if such swaps caused the floor trader’s total gross notional IRS outstanding to exceed the *de minimis* amount of \$8 billion. The FIA PTG’s proposed no-action relief did not include an exclusion from the *de minimis* Swap Dealer registration requirement for non-cleared/off-SEF/customized IRS if executed by registered floor traders for *dealing purposes*. See FIA PTG (February 2016), *op. cit.*, at 3-4.

⁸² Quoted in Rennison and Jopson, *op. cit.*

⁸³ Rennison and Jopson, *op. cit.*

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- In August 2018, FIA together with its PTG again expressed concern to the CFTC about regulatory uncertainty arising from the Floor Trader Exclusion: “[R]educing unnecessary regulatory impediments that inhibit market participants from engaging in on-platform trading for fear of exceeding the *de minimis* threshold would facilitate this growth.”⁸⁴
- In February 2019, then CFTC chairman Christopher Giancarlo indicated his intention for the Commission to clarify the Floor Trader Exclusion.⁸⁵ The reaction from the HFT and PTF community was strongly positive and directly at odds with Plaintiffs’ experts’ contentions that regulatory costs and uncertainty were not important in preventing such firms from providing IRS liquidity.⁸⁶
- On June 27, 2019, the CFTC issued a no-action letter in response to the FIA PTG’s request three years and four months earlier in which the CFTC acceded to the FIA PTG’s requests and agreed not to take enforcement action against registered floor traders based on their IRS activities involving non-cleared, off-SEF IRS, swaps with customized and negotiated terms, and failures to provide the CFTC with risk-related reports and disclosures.⁸⁷ The widely positive response to the CFTC’s no-action relief provides further evidence against Plaintiffs’ experts’ contentions that regulatory uncertainty and potential Dealer registration costs were not the main impediment to liquidity provision by HFTs and PTFs during the Class Period. For example, CFTC Commissioner Dan Berkovitz explained:

I believe the floor trader registration category is appropriate for proprietary traders who provide liquidity on electronic trading platforms, but in so doing, do not act as traditional dealers by soliciting customers or negotiating swap terms other than price or quantity. The current floor trader rule has not worked as intended. Potential sources of liquidity have not entered into these markets due to concerns about the potential breadth of the restrictions in the current provision....⁸⁸

53. Despite (or perhaps because of) all of the above evidence, Prof. Duffie speculates in the Duffie Reply Report that the CFTC’s regulations were themselves impacted by the alleged conspiracy, claiming that “[t]he but-for advent of AA2A trade [sic] is an obvious change in market conditions that would likely have stimulated CFTC rule changes that encouraged entry by

⁸⁴ Letter from A. Lurton (FIA) to C. Kirkpatrick (CFTC Secretary), “De Minimis Exception to the Swap Dealer Definition (RIN 3038-AE68)” (August 13, 2018), at 4 & 7.

⁸⁵ C. J. Giancarlo, “Remarks,” *DerivCon 2019 Conference* (February 27, 2019), at <https://www.cftc.gov/PressRoom/SpeechesTestimony/opagiancarlo65> (last visited June 7, 2019).

⁸⁶ For example, Chris Hehmeyer (founder and head of Hehmeyer Trading + Investments and a member of the FIA PTG) reacted to Giancarlo’s speech and the news that the CFTC was finally addressing the Floor Trader Exclusion in an interview with *Risk* as follows: “[The CFTC is] correct to do so. The ‘floor trader’ solution is imperfect for all the parties involved and nobody likes it.” (Quoted in R. M. Smith, “Giancarlo Opens Door for Prop Firms to Quote Swaps,” *Risk* (March 1, 2019).)

⁸⁷ CFTC No-Action Letter (June 2019), *op. cit.*, at 3.

⁸⁸ Dan M. Berkovitz, *Statement in Support of the Staff No Action Letter Regarding Floor Traders* (June 27, 2019), at <https://www.cftc.gov/PressRoom/SpeechesTestimony/berkovitzstatement062719>.

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additional new dealers.”⁸⁹ Despite recognizing the issues that Commissioner Berkovitz identified, Prof. Duffie nevertheless concludes that “absent the alleged conspiracy, high regulatory hurdles to dealer entry to AA2A trading venues would have been resolved in the but-for world.”⁹⁰ Yet, Prof. Duffie has provided no evidence to substantiate his view.

54. If anything, it is possible that volumes might have *decreased* in the but-for world because liquidity could have become fragmented across multiple trading platforms which could in turn have increased spreads and discouraged some market participants from trading. For example, as I explained in my Opening Report, “fragmented derivatives markets can also create barriers to entry which, in turn, lead to a fall in the number of participants that are able to mutualize risk and collectively withstand the next adverse market event....”⁹¹ As the Financial Stability Board explains, moreover, “[t]here are a variety of reasons for market fragmentation, not all of which are undesirable or attributable to the effects of regulation and supervision. What may sometimes appear as fragmented markets can simply reflect investor preferences...of their trading (e.g. via venues with varying degrees of price and counterparty transparency).”⁹²

55. Furthermore, the increase in demand for IRS usage and the resulting increase in volume hypothesized by Plaintiffs’ experts absent the alleged conspiracy would have needed to have been extreme to change the results of my empirical test of sufficient liquidity. Table II-2 shows average daily notional trading volume of USD-denominated, cleared, on-SEF IRS trades for various IRS tenors between February 15, 2014, and December 31, 2017 that I showed in my Opening Report Table III-8.⁹³ Table II-2 also shows the percentage increase in average daily trading volume for each USD IRS tenor that would have been required in the but-for world to reach the Lower Minimum Liquidity Bound. For example, one-year IRS with any start-date conventions and/or floating reference rate types would have to have experienced a 44 percent increase in average daily notional volume in the but-for world to exceed the Lower Minimum

⁸⁹ Duffie Reply Report, *op. cit.*, at ¶375.

⁹⁰ Duffie Reply Report, *op. cit.*, at ¶377.

⁹¹ Culp Report, *op. cit.* at ¶282. See also Futures Industry Association, *Mitigating the Risk of Market Fragmentation* (March 2019), at 2, and Financial Stability Board, *FSB Report on Market Fragmentation* (June 4, 2019).

⁹² Financial Stability Board (2019), *op. cit.*, at 4.

⁹³ “The average daily notional volumes exclude Non-Price-Forming compression transactions, noncleared trades, and off-SEF transactions (whether cleared or not).” Culp Report, *op. cit.* at ¶187.

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Liquidity Bound and be potentially suitable for AA2A execution. Looking only at one-year IRS with spot starting dates and 3mLIBOR reference rates (*i.e.*, the properties of a benchmark swap), a *166 percent increase* in average daily notional volume would have been required to exceed the Lower Minimum Liquidity Bound. Volumes on 30-year IRS with spot-starting dates and 3mLIBOR floating reference rates would have to have been *462 percent higher* in the but-for world to have exceeded the Lower Minimum Liquidity Bound. Any realistic increase in trading volumes in Plaintiffs' but-for world would not have changed the conclusions of my liquidity test.

Table II-2: Average Daily Number of Trades and Average Daily Notional Amounts of USD Fixed/Float On-SEF, Cleared IRS – Percentage Volume Growth by Tenor Required to Exceed Lower Liquidity Bound (\$mns)

<i>Tenor^a</i>	<i>All Start Dates and All Floating Rate Benchmarks</i>		<i>Spot Start IRS Referencing 3mLIBOR</i>	
	<i>Avg Daily Notional Traded^b</i>	<i>Percentage Increase to Reach the Lower Liquidity Bound</i>	<i>Avg Daily Notional Traded^b</i>	<i>Percentage Increase to Reach the Lower Liquidity Bound</i>
5-yr	\$5,035.26	0%	\$2,965.33	8%
10-yr	\$4,235.89	0%	\$2,740.23	17%
2-yr	\$3,985.83	0%	\$2,529.90	27%
1-yr	\$2,223.73	44%	\$1,207.11	166%
3-yr	\$1,904.20	68%	\$1,524.95	110%
7-yr	\$1,033.51	210%	\$693.84	362%
30-yr	\$842.24	281%	\$570.13	462%
4-yr	\$734.95	336%	\$633.59	406%
3-mth	\$527.93	507%	\$5.60	57178%
6-yr	\$352.20	810%	\$233.52	1272%

SOURCE: Clarus SDRView. **NOTES:** Includes all price-forming USD fixed/float and basis IRS (excluding compressions). Averages are calculated using the total number of trading days over the period 2/15/2014 - 12/31/2017. ^a: Tenor is the difference between the effective and maturity date and calculated empirically using Prof. Grinblatt's methodology. ^b: Gray-shaded cells indicate amounts above Lower Minimum Liquidity Bounds.

III. THE ROLE OF TICK SIZES AND BID-ASK SPREADS ON CLOBs

56. In my Opening Report, I opined that even if IRS trades migrated to AA2A CLOBs, they would be unlikely to experience the degree of spread compression that Prof. Grinblatt predicts because all CLOBs have minimum tick sizes (the smallest increment in which prices can be quoted) that are effectively a floor on the bid-ask spread.⁹⁴ Even if an IRS trades on a CLOB at a spread of 0.50 bps (*i.e.*, the minimum tick size of most Eurodollar futures, which are the most liquid CLOB-traded product in the actual world), it would still trade at more than 10 times the spread Prof. Grinblatt predicts for Plaintiffs' but-for world.⁹⁵ A 0.50 bps spread is also

⁹⁴ Culp Report, *op. cit.*, at ¶¶193-95.

⁹⁵ Culp Report, *op. cit.*, at ¶¶193-95.

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significantly wider than the spreads currently available via D2C RFQ (on the Bloomberg and Tradeweb SEFs), making it highly unlikely that most putative Class Members would benefit from trading IRS on an AA2A venue in the but-for world, even if the AA2A IRS CLOB were as liquid as the exchange CLOB on which Eurodollar futures are traded.⁹⁶

57. Prof. Grinblatt disagrees with my conclusion that a CLOB's minimum tick size operates as a floor on the bid-ask spread available to buy-side traders because he believes it is an "arbitrary threshold" that can change over time and at the discretion of the platform listing the product.⁹⁷ He argues, for instance, that even though Tera, Javelin, and trueEX had minimum tick sizes that were greater than the spreads he predicts would have occurred in the but-for world, those platforms were prepared to lower their minimum tick sizes but were supposedly unable to do so because of the threat of the alleged boycott.⁹⁸ Prof. Grinblatt's belief, however, is based on a fundamental misunderstanding of the role of tick sizes and the market forces that influence a platform operator's decision to set a minimum tick size.

58. The tick size of a standardized exchange-traded contract is the minimum increment of a price change for that contract as defined by the platform operator that lists that contract for execution (*i.e.*, in the U.S., a CFTC-regulated DCM or registered SEF).⁹⁹ The tick size is determined by the platform operator and varies by product. For example, the minimum price increments for NYSE stocks is \$0.01, and the minimum price increment for CME Eurodollar

⁹⁶ Culp Report, *op. cit.*, at ¶195, Table III-6.

⁹⁷ Grinblatt Rebuttal Report, *op. cit.*, at ¶¶199-200.

⁹⁸ Grinblatt Rebuttal Report, *op. cit.*, at ¶¶198-201.

⁹⁹ Plaintiffs criticize my definition of the minimum tick size, even though I used a well-understood definition of the term. ("Dr. Culp believes that minimum tick size is the smallest increment at which a price can be quoted and traded, although he cited nothing for that proposition either. (Ex. 1, 258:9-15.) Although he 'can't think of an exception to this' rule, he did nothing to investigate. (Ex. 1, 259:14-24.)" Ptfs MOL ISO Culp Exclusion, *op. cit.*, at 14.) Yet, I did provide a citation for my definition that was presented in Table III-1 of my Opening Report, *op. cit.* Furthermore, as indicated in the previous footnote, independent sources including Prof. Duffie and the CFTC agree with my definition. *See, e.g.*, D. Duffie, *Futures Markets* (New York, N.Y.: McGraw-Hill, 1989), at 24, Chicago Board of Trade, *The Chicago Board of Trade Handbook of Futures and Options* (New York, N.Y.: McGraw-Hill, 2006) (hereinafter "CBOT Handbook"), at 34 & 434, and Commodity Futures Trading Commission, "Minimum Price Fluctuation (Minimum Tick)," *Glossary*, at https://www.cftc.gov/ConsumerProtection/EducationCenter/CFTCGlossary/glossary_m.html#minimumpricefluctuation.

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futures is 0.50 bps (or 0.25 bps for the front-month expiring contract).¹⁰⁰ As discussed in Section II.B, I defined fully liquid Eurodollar futures in my test of liquidity sufficiency as those contracts for which the median best bid-ask spread was equal to the minimum tick size of 0.50 bps (or 0.25 bps for the front-month expiring contract).¹⁰¹

59. Prof. Grinblatt criticizes my comparison of quoted Eurodollar futures bid-ask spreads relative to minimum tick sizes to define the Upper and Lower Minimum Liquidity Bounds in my liquidity test because, according to him, the minimum tick size reflects an arbitrary threshold or floor that can change over time at the discretion of the platform operator listing the product.¹⁰² Counter to Prof. Grinblatt's view of the irrelevance of supposedly ad hoc tick sizes, exchanges and platforms typically view tick sizes as an important dimension of their products and only change tick sizes after an *ex-ante* review of the market quality and liquidity of a particular contract. In particular, the potential for the success or failure of any listed contract depends critically on its tick size. Furthermore, tick sizes are also an important input to the variation margin payments for cleared derivatives, which are the daily cash-only pay/collect amounts owed to (payable by) clearing futures commission merchants ("FCMs") for their own accounts or on behalf of their customers.¹⁰³

A. Determinants of Minimum Tick Sizes

60. Platform operators and regulators are attentive to tick sizes because of the significant consequences of tick size on the cost of trading, market liquidity, and price discovery.¹⁰⁴ Prof.

¹⁰⁰ Culp Report, *op. cit.*, at ¶172. See also Securities and Exchange Commission, *Division of Market Regulation: Responses to Frequently Asked Questions Concerning Rule 612 (Minimum Pricing Increment) of Regulation NMS* (Oct. 21, 2005), <https://www.sec.gov/divisions/marketreg/subpenny612faq.htm>.

¹⁰¹ Culp Report, *op. cit.*, at ¶¶177-178.

¹⁰² Grinblatt Reply Report, at ¶¶199-200.

¹⁰³ As discussed in my Opening Report, all open positions in CCP-cleared derivatives listed for trading by a U.S. futures exchange or SEF are marked to their current market values by the CCP at least twice daily. (Culp Report, *op. cit.*, at ¶475.) Traders with open positions that experience a gain (loss) vis-à-vis the previous mark-to-market are entitled to withdraw (must deposit) cash amounts corresponding to the latest mark-to-market price changes. See, e.g., T. E. Petzel, *Financial Futures and Options* (New York, N.Y.: Quorum Books, 1989), at 21, CBOT Handbook, *op. cit.*, at 56 & 423, and J. W. Labuszewski, "Futures Market Fundamentals," in *The CME Group Risk Management Handbook: Products and Applications* (Hoboken, N.J.: John Wiley & Sons, Inc., 2010), at 40.

¹⁰⁴ See, CME Group, *Tick Movements: Understanding How They Work*, <https://www.cmegroup.com/education/courses/introduction-to-futures/tick-movements-understanding-how-they-work.html>. See also L. Harris, *Trading and Exchanges: Market Microstructure for Practitioners* (Oxford: Oxford University Press, 2003), at 81.

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Duffie acknowledged exchanges' and other platforms' expertise in this area at his deposition, noting that he "wouldn't try to second guess" platform operators setting of the tick size.¹⁰⁵ In his Reply Report, moreover, Prof. Duffie recognizes that a "platform operator has an obvious incentive to ensure that it sets tick size at a level consistent with the viability of platform trade."¹⁰⁶

61. The "optimal tick size" for a particular derivatives contract and venue requires a delicate balancing act by platform operators.¹⁰⁷ All else equal, the smaller the tick size the lower the transaction costs for buy-side customers that are net demanders of liquidity. Yet, the minimum tick size also provides a minimum level of compensation to market makers and other liquidity providers that helps ensure a steady supply of liquidity. A wider tick size typically enhances the profitability of liquidity suppliers and thus can also enhance overall liquidity and improve market quality, and benefit buy-side customers.¹⁰⁸ In addition, wider tick sizes can reduce the number of possible prices at which to trade, which can enhance the operational efficiency of some platforms.¹⁰⁹ So, either decreases or increases in minimum tick size can lead to higher liquidity in different circumstances, and platform operators pay particular attention to the potential liquidity impacts of changes in minimum tick size.

62. Accordingly, contrary to Prof. Grinblatt's characterization of tick sizes as arbitrary and divorced from commercial and liquidity considerations, exchanges and other execution venues dedicate considerable time and resources to determining and reviewing tick sizes and must constantly evaluate the balance between lower costs for buy-side liquidity demanders associated with smaller tick sizes and higher compensation to liquidity providers through higher minimum

¹⁰⁵ Deposition of D. Duffie, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (April 22, 2019) (hereinafter "Duffie Dep. Tr."), at 178:25-179:14.

¹⁰⁶ Duffie Reply Report, *op. cit.*, at ¶200.

¹⁰⁷ Also related to minimum tick size is the contract multiplier for a futures contract. See, e.g., J. W. Labuszewski, "Stock Index Futures Fundamentals," in *The CME Group Risk Management Handbook: Products and Applications* (Hoboken, N.J.: John Wiley & Sons, Inc., 2010), at 138.

¹⁰⁸ See, e.g., S. J. Grossman and M. H. Miller, "Liquidity and Market Structure," *Journal of Finance* Vol. 43, No. 3 (July 1988), and N. P. B. Bollen, T. Smith, and R. E. Whaley, "Optimal Contract Design: For Whom?" *The Journal of Futures Markets* Vol. 23, No. 8, (2003).

¹⁰⁹ S. Brown, P. Laux, and B. Schachter, "On the Existence of an Optimal Tick Size," *Review of Futures Markets*, 10, (1991).

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tick size amounts. As Jigar Patel (Global Head of Business Development at electronic market-maker XTX Markets) explained, “Regularly reviewing tick sizes to ensure that they are balanced, i.e. neither too small nor too large, is one of the key roles of a venue.”¹¹⁰ Zubin Ramdarshan (Head of Equity & Index Product Design at Eurex) also explained: “Tick size is a sensitive topic....The key point is does it improve liquidity and grow liquidity.”¹¹¹ Further, in a report commissioned by the U.K. Government on the potential regulation of minimum tick sizes for equity securities, Dr. James J. Angel concluded:

The optimal tick size thus represents a tradeoff. A wider tick provides more incentives for investors to place limit orders, thus boosting the liquidity displayed in a limit order book. A wider tick likewise results in a higher minimum bid-ask spread, increasing the profitability of market making and motivating more firms to engage in market making activities, also increasing liquidity. However, higher minimum bid-ask spreads increase transactions costs for investors, thus inhibiting trading and reducing liquidity. The optimal tick size is a tradeoff between these two opposing forces.¹¹²

63. Because of the product-by-product relationship between minimum tick size and liquidity, platforms must typically monitor and assess the effects of tick size on trading for a particular product. For example, in response to a question on Eurex’s process for changing tick sizes, Eurex’s Mr. Ramdarshan said: “[W]e do not take such a measure lightly. We do a lot of consultation with clients in advance and perform detailed analysis of contract data before deciding on any changes.”¹¹³ Similarly, Dr. Angel commented as follows:

[T]hat various measures of market quality increase after a change in tick sizes... should not be surprising, because such changes are not random events. Exchanges generally are only going to change the tick size when they feel it is in their best interest to do so, and an improvement in market quality will generally result in more trading volume and hence revenue for the exchange. Likewise, an empirical finding that a reduction in tick size led to an improvement in market quality does not imply that reducing tick size still further will result in an even greater improvement, as there

¹¹⁰ Quoted in L. Chender, “Tick Trade-Offs and the Optimal Size,” *Futures and Options World* (July 26, 2019).

¹¹¹ Quoted in Chender (July 2019), *op. cit.*

¹¹² J. J. Angel, “Tick Size Regulation: Costs, Benefits, and Risks,” *Economic Impact Assessment EIA7 – Project Foresight Report, U.K. Government Office for Science* (2012), at 7.

¹¹³ Eurex Exchange, Eurex Clearing, Eurex Group, “Ticking the Box: Tick Size Reduction for Futures Calendar Spreads for EURO STOXX/STOXX Europe 600-Banks Futures,” *Press Release* (July 22, 2019), at <https://deutsche-boerse.com/group-en/newsroom/focus/Ticking-the-box-tick-size-reduction-for-futures-calendar-spreads-for-EURO-STOXX-STOXX-Europe-600-Banks-Futures-1584002>.

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is likely an optimal tick size and it is possible to set the actual tick too low as well as too high.¹¹⁴

64. Although Prof. Grinblatt recognizes that exchanges can and do change the minimum tick size of certain contracts over time, he implies that such changes only benefit dealers and other liquidity providers to the detriment of buy-side liquidity demanders, noting: “in determining optimal tick size, by imposing rules that tend to increase their profits, platform operators seek to attract liquidity providers.”¹¹⁵ But Prof. Grinblatt provides no evidence to substantiate any such bias. Indeed, it would be self-defeating for a platform operator to ignore liquidity demanders’ considerations of cost in tick size determinations because such platform operators profit from increases in total trading activity that come from liquidity demanders and liquidity providers alike.

65. For example, as Prof. Grinblatt acknowledges, the CME reduced the minimum tick size for its two-year Treasury note futures contract by 50 percent, from 1/4 of 1/32 to 1/8 of 1/32, in January 2019.¹¹⁶ In the month after the implementation of the minimum tick size reduction, volume in the CME two-year note futures contract was 20,428,157 contracts – more than double the 10,151,275 contracts traded in the prior month of January.¹¹⁷ Average monthly volume for February through September 2019, moreover, was 45 percent higher than average monthly volume over the same months in 2018 (*i.e.*, 15,882,937 in 2019 as compared to 10,963,550 in 2018).¹¹⁸

66. Published empirical academic studies of trading platforms such as the American Stock Exchange, Australian Stock Exchange, New York Stock Exchange, Sydney Futures Exchange, Toronto Stock Exchange, and others generally show that reductions in minimum tick sizes

¹¹⁴ Angel, *op. cit.*, at 8.

¹¹⁵ Grinblatt Reply Report, *op. cit.*, at ¶200.

¹¹⁶ Grinblatt Reply Report, *op. cit.*, at ¶200. *See also* CME Group, *Tick Reduction for CBOT Two-Year Note Futures* (May 17, 2018), <https://www.cmegroup.com/notices/clearing/2018/05/Chadv18-192.html>.

¹¹⁷ Based on data from the Futures Industry Association. Note, moreover, that the minimum tick size reduction was effective as of January 13, 2019, and thus likely impacted January 2019 volume, as well.

¹¹⁸ Based on data from the Futures Industry Association.

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resulted in lower spreads and higher trading volume, benefits to retail buy-side customers trading in relatively small amounts, and sometimes also reduced depth in the limit order book.^{119,120}

B. Tick Size and Bid-Ask Spread

67. As discussed in the previous section, changes in tick sizes often impact changes in bid-ask spreads, and tick sizes can serve as proxies for changes in market liquidity. The relationship between minimum tick size and bid-ask spreads (on which I base my liquidity analysis) is a result of the design of CLOBs with order matching algorithms that are based on price and time. As Harris explains, “a tick rule is essential if time priority is to have any meaning. Time priority has little meaning if the person who is first to quote the best bid can lose that position to someone who quotes only a penny more.”¹²¹

68. For highly liquid futures contracts, the minimum tick size acts as a binding constraint on the minimum best bid-offer spread that buy-side customers must pay to sell-side liquidity providers.¹²² For example, as shown in Exhibits III-2 and III-3 of my Opening Report, the Eurodollar futures contract where the minimum tick size stops being the binding constraint on best bid-offer spreads coincides with the point where per-contract liquidity begins to decrease significantly.

¹¹⁹ See, e.g., H. Ahn, C. Cao, and H. Choe, “Tick Size, Spread, and Volume,” *Journal of Financial Intermediation* Vol. 5 (1996), J. Bacidore, “The Impact of Decimalization on Market Quality: An Empirical Investigation of the Toronto Stock Exchange,” *Journal of Financial Intermediation* Vol. 6 (1997), D. C. Porter and D. G. Weaver, “Tick Size and Market Quality,” *Financial Management* Vol. 26, No. 4 (1997), N. P. B. Bollen and R. E. Whaley, “Are ‘Teenies’ Better?” *Journal of Portfolio Management* Vol. 24 (Fall 1998), M. A. Goldstein and K. A. Kavajecz, “Eighths, Sixteenths, and Market Depth: Changes in Tick Size and Liquidity Provision on the NYSE,” *Journal of Financial Economics* Vol. 56 (2000), H. Bessembinder, “Trade Execution Costs and Market Quality After Decimalization,” *Journal of Financial and Quantitative Analysis* Vol. 38, No. 4 (December 2003), M. Aitken and C. Comerton-Forde, “Do Reductions in Tick Size Influence Liquidity?” *Accounting and Finance* Vol. 45 (2005), and K. Alampieski and A. Lepone, “Impact of a Tick Size Reduction on Liquidity: Evidence from the Sydney Futures Exchange,” *Accounting and Finance* Vol. 49, No. 1 (2009).

¹²⁰ Reduced limit order depth is not necessarily indicative of a reduction in overall market quality. Depth of the limit order book reflects *potential* volume at off-market prices, but if a decline in depth is accompanied by an increase in at-market volume then overall liquidity and market quality may not be affected.

¹²¹ R. D. Huang and H. R. Stoll, “Tick Size, Bid-Ask Spreads, and Market Structure,” *Journal of Financial and Quantitative Analysis* Vol. 36, No. 4 (2001). See also Angel, *op. cit.*, at 5, and L. Harris, “Stock Price Clustering and Discreteness,” *Review of Financial Studies* Vol. 4, No. 3 (1991).

¹²² See Harris (1991), *op. cit.*, at 390, and A. Kurov and T. Zabotina, “Is it Time to Reduce the Minimum Tick Sizes of the E-Mini Futures,” *Journal of Futures Markets* (January 2005).

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69. Even Prof. Duffie conceded at his deposition that the tick size represents a lower bound on the best bid and offer and that price increments on a CLOB cannot be smaller than the minimum tick size.¹²³ I further note that CME, when discussing the liquidity of its interest rate products, includes the percentage of best bid and offer quotes at the minimum price increment as a metric of market liquidity, which further supports my analysis and opinions.¹²⁴

IV. PLAINTIFFS' PRODUCT SUBSTITUTION AND SPREAD PROPAGATION THEORIES AND THE NEED FOR INDIVIDUALIZED INQUIRIES

A. Product Substitution

70. In my Opening Report, I explained that Plaintiffs' experts' opinions regarding Product Substitution were flawed because they failed to recognize that increases in basis risk and costs associated with substituting more standardized AA2A-traded IRS for less standardized IRS could outweigh any hypothetical reductions in execution costs.¹²⁵ In my discussion of Plaintiffs' experts' Product Substitution arguments in my Opening Report (or deposition), I did not assume or conclude that no Class Members would benefit from lower execution costs in Plaintiffs' but-for world. Rather, I concluded that even if some Class Members received lower execution costs, any assessment of Product Substitution would need to balance the potential benefits from reduced execution costs against the perceived harms from increased basis risks (or market fragmentation liquidity risks) for each putative Class Member. This is an inherently individualized inquiry and cannot be analyzed on a Class-wide basis.

71. In their Reply Reports, Profs. Duffie and Grinblatt both mischaracterize my opinions regarding Product Substitution and ignore the individualized issues that the execution cost/basis risk trade-off necessarily implies. For example, Prof. Duffie asserts that "Dr. Culp argues that substitution is unlikely to be attractive due to basis risk,"¹²⁶ thus implying that I dismissed outright the possibility that any putative Class Members would substitute more standardized products for less standardized products, assuming (*arguendo*) that execution costs would

¹²³ Duffie Dep. Tr., *op. cit.*, at 169:6-15. See also Duffie Reply Report, *op. cit.*, at ¶199.

¹²⁴ See <https://www.cmegroup.com/education/featured-reports/interest-rate-futures-liquidity-update.html>.

¹²⁵ Culp Report, *op. cit.*, at ¶207.

¹²⁶ Duffie Reply Report, *op. cit.*, at ¶99.

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improve in the but-for world. But this is a plain misreading of my Opening Report, which emphasizes the individualized nature of the question, not the impossibility of substitution:

To determine whether any particular buy-side firm would realistically and reasonably have substituted AA2A for voice or RFQ execution of more customized IRS products that better-suited their risk management objectives, one would need not only to consider that firm's basis risk exposure, but also the extent (if any) to which the firm would have incurred additional costs in the but-for world and that firm's tolerance for trading off higher basis risk for lower execution costs.¹²⁷

I explain how buy-side IRS users would also have considered basis risk in choosing whether to execute customized OTC IRS tailored to their risk management and/or investment objectives vis-à-vis standardized IRS available at (*arguendo*) lower spreads.¹²⁸

72. Similarly, Prof. Grinblatt asserts that my "arguments only consider the purported, incremental costs of substitution and ignore the cost savings and other benefits that would accrue to the buy-side from AA2A trading."¹²⁹ Again, this is a misreading of my Opening Report. As the above quote demonstrates, my opinion does not ignore potential improvements in execution costs, but rather emphasizes that Plaintiffs' experts cannot dismiss the importance that basis risks and other costs could have for certain putative Class Members. In other words, neither side of the equation can be ignored, and *both* must be considered on a case-by-case basis. This requires individualized inquiries to determine each putative Class Member's tolerance for incurring basis risk compared to potentially lower expected execution costs.

73. Indeed, Plaintiffs' experts appear to recognize that the fact of substitution cannot be presumed for all putative Class Members. Specifically, Profs. Duffie's and Grinblatt's arguments about Spread Propagation (or "price discipline," as they prefer – *see* Section IV.B) are only relevant if not all IRS products substitute to standardized AA2A products in the but-for world. In fact, Plaintiffs' experts discuss the problems posed by "orphaned products" in their but-for world, thus acknowledging that not all trades will move to AA2A venues, but they have provided no basis for determining which specific putative Class Members would have substituted their

¹²⁷ Culp Report, *op. cit.*, at ¶206.

¹²⁸ Culp Report, *op. cit.*, at ¶211.

¹²⁹ Grinblatt Reply Report, *op. cit.*, at ¶85.

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non-standardized off-SEF IRS to standardized AA2A-traded products and which products would have been substituted by those particular Class Members.

B. Spread Propagation

74. In my Opening Report, I explained that Profs. Duffie's and Grinblatt's contention that spreads on relatively customized IRS which remained executed by voice or RFQ in Plaintiffs' but-for world would have compressed as a result of greater price transparency and competition (the "Spread Propagation" hypothesis) was flawed for several reasons.¹³⁰ First, I explained that AA2A trading in-and-of itself would not provide a substantial increase in transparency vis-à-vis the price transparency resulting from the already-extant requirements of the Dodd-Frank Act. Second, I noted that Plaintiffs' experts' Spread Propagation theory is predicated on their incorrect Product Substitution theory, and, even assuming that theory was correct, would require individualized inquiries to determine which putative Class Members would pose a credible competitive threat of substitution to their dealers. Third, I discussed that Plaintiffs' experts ignore the fact that the reduced off-SEF volumes associated with their Product Substitution theory likely would reduce liquidity and increase spreads for the customized products that remain off of AA2A venues in Plaintiffs' but-for world (*i.e.*, that there would be liquidity fragmentation).

75. In this section, I address Plaintiffs' and their experts' criticisms of my opinions in my Opening Report on Spread Propagation, both concerning my terminology and the inconsistencies of their arguments about liquidity fragmentation with their own writings and the empirical evidence. I also show that Plaintiffs' experts' reliance on academic literature to criticize my opinions regarding price transparency is flawed and incorrect.

(1) Conceptual Issues and Terminology

76. Plaintiffs' and their experts' main responses to my opinions regarding their Spread Propagation theories appear to be purely semantic, attacking my choice of the short-hand term "Spread Propagation" to refer to Profs. Duffie's and Grinblatt's theories.¹³¹ As I made clear in

¹³⁰ Culp Report, *op. cit.*, at ¶¶27-30.

¹³¹ See, e.g., Duffie Reply Report, *op. cit.*, at ¶94, Grinblatt Reply Report, *op. cit.*, at ¶75, and Ptfs MOL ISO Culp Exclusion, *op. cit.*, at 9-12.

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my Opening Report and at my deposition, however, I adopted the phrase “Spread Propagation” simply as shorthand for the theory espoused by Profs. Grinblatt and Duffie that IRS not traded on AA2A venues in the but-for world nevertheless would have benefitted from tighter spreads on relatively more standardized AA2A-traded IRS. More particularly, I explained in my Opening Report:

Prof. Duffie’s rationale for this theory [that non-AA2A traded IRS would have been impacted by the alleged conspiracy] is that “the price terms of trade [sic] offered by dealers to buy-side firms would have been more competitive, and thus more advantageous to the buy-side.” He claims this “propagation” of the supposed compression in spreads in the but-for world would result from “increases in price transparency and competition for their orders.” Prof. Grinblatt also opines that bid-ask spreads for trades that remain off-SEF would compress through “better information about true IRS values and greater competition among liquidity providers for...transactions.” *I henceforth refer to this as Plaintiffs’ experts’ alleged “Spread Propagation Theory” (or simply “Spread Propagation”).* [emphasis added]¹³²

77. Somewhat ironically, Plaintiffs’ experts now appear to have determined that they, too, would like to use shorthand to refer to their theory. Both the Duffie and Grinblatt Reply Reports employ the shorthand “price discipline” in reference to the same theory.¹³³ I could not have relied on that nomenclature, however, because it did not appear in either of Plaintiffs’ experts’ original reports. Nevertheless, “Spread Propagation” and “price discipline” refer to the same economic concept, whatever one chooses to call it.

(2) Liquidity Fragmentation

78. In the context of assessing Plaintiffs’ experts’ Spread Propagation theory, I explained in my Opening Report that market and liquidity fragmentation across execution platforms, markets, and jurisdictions drives a wedge between the execution prices of the same or very similar IRS products available for trading on different platforms.¹³⁴ Such market and liquidity fragmentation is a barrier to Plaintiffs’ experts’ Spread Propagation theory because it limits the value and

¹³² Culp Report, *op. cit.*, at ¶262.

¹³³ See, e.g., Duffie Reply Report, *op. cit.*, at ¶¶11, 21, 85, 88, 92, 94-96, 157, 221, & 262, and Grinblatt Reply Report, *op. cit.*, at ¶¶13, 16, & 65-83.

¹³⁴ Culp Report, *op. cit.*, at Section V.

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reliability of prices on alternative platforms (no matter how transparent those prices are) as a source of price discipline for products executed in markets with differentiated liquidity pools.

79. Plaintiffs' experts admit that some products, such as large notional executions or some customized IRS, would not have transitioned onto AA2A platforms even in the but-for world.¹³⁵ Prof. Duffie explains the natural tendency of liquidity to consolidate at a particular execution venue after liquidity reaches a "tipping point."¹³⁶ If market participants have a choice in venue or if frictions inhibit the natural consolidation of liquidity on a particular platform, market liquidity could fragment across these multiple venues, potentially resulting in higher execution costs on each individual platform.¹³⁷

80. Prof. Duffie's own writing discusses that "[a]nother important loss of market competition arises from the fragmentation of trade across many different trade platforms. Well-established economic theory implies that markets are more efficient, and investors receive better pricing when more market participants compete for trade at the same venue."¹³⁸ In his Reply Report, Prof. Duffie also offers such an example of market fragmentation in the but-for world by acknowledging that some products are not suitable for AA2A trading and that such "orphaned products" would remain off-SEF.¹³⁹ By his own admission in prior writings, liquidity fragmentation means that when *fewer* market participants compete in a single and integrated liquidity pool or when liquidity pools are not integrated, those markets are less efficient and pricing is worse.

81. In my Opening Report, I offered two examples of how fragmentation in liquidity pools have affected IRS prices and/or spreads. First, I discussed how spreads on EUR-denominated

¹³⁵ Duffie Report, *op. cit.*, at ¶¶130-131.

¹³⁶ Duffie Report, *op. cit.*, at ¶134.

¹³⁷ See, e.g., H. Bessembinder, "Quote-Based Competition and Trade Execution Costs in NYSE-Listed Stocks," *Journal of Financial Economics* Vol. 70 (2003), B. Boehmer, and E. Boehmer, "Trading Your Neighbor's ETFs: Competition and Fragmentation?" *Journal of Banking and Finance* Vol. 27 (2003), M. A. Goldstein, A. V. Shkilko, B. F. Van Ness, and R. A. Van Ness, "Competition in the Market for NASDAQ Securities," *Journal of Financial Markets* Vol. 113 (2008), and B. Biais, C. Bisière, and C. Spatt, "Imperfect Competition in Financial Markets: An Empirical Study of Island and Nasdaq," *Management Science* Vol. 56 (2010).

¹³⁸ D. Duffie, "Financial Regulatory Reform After the Crisis: An Assessment," *Management Science* Vol. 64 (2018), at 28.

¹³⁹ Duffie Reply Report, *op. cit.*, at ¶¶62-63.

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fixed/floating IRS executed on U.S. SEFs had widened over a similar time period, during which USD-denominated IRS spreads declined in large part because of the flight of transaction volume to the E.U. This example demonstrates that the costs of liquidity fragmentation can exceed any benefits from additional price transparency, as greater post-trade price transparency provided by Dodd-Frank regulations did not abrogate the impact of liquidity fragmentation and the expansion of spreads for these EUR-denominated transactions.¹⁴⁰

82. Prof. Duffie essentially dismisses this example because the liquidity bifurcation was based on regulation: “I agree with Dr. Culp that the adverse liquidity impact of this bifurcation of the EUR swap market was induced by regulatory differences. This is unrelated to the costs and benefits of introducing a more competitive trade protocol.”¹⁴¹ But the source of liquidity fragmentation is irrelevant – the fact is that both Prof. Duffie and I agree that market fragmentation can have adverse liquidity impacts.

83. Second, I noted the differences or “clearing basis” between fixed rates on otherwise-identical IRS cleared by CME vis-à-vis those cleared by LCH *and* IRS cleared by Eurex vis-à-vis LCH.¹⁴² Prof. Duffie responds to my example of the clearing basis as follows:

Dr. Culp mistakenly suggests that the existence of a clearing basis, caused by a regulatory fragmentation of the IRS market between two different jurisdictions, somehow implies that buyside firms would not be in a position to take advantage in the but-for world of the price-disciplining effect of arbitrage between quotes offered to them by dealers at RFQ platforms and prices available on anonymous all-to-all platforms in the same jurisdiction. Dr. Culp’s use of the clearing basis as an example to make this argument is not logically correct. There is no regulatory or other institutional barriers that would prevent large buyside firms from executing trades using both D2C RFQ protocols and AA2A protocols *in the same jurisdiction*, other than the alleged conspiracy of the dealers.¹⁴³

84. Prof. Duffie’s reply to my discussion of the clearing basis is both inapplicable and incorrect. As I explained in my Opening Report, the primary driver of the IRS clearing basis is

¹⁴⁰ Culp Report, *op. cit.*, at ¶¶288-295.

¹⁴¹ Duffie Reply Report, *op. cit.*, at ¶61.

¹⁴² Culp Report, *op. cit.*, at ¶¶296-308.

¹⁴³ Duffie Reply Report, *op. cit.*, at ¶104.

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not cross-border regulators' recognition of CCPs (as Prof. Duffie claims). Rather, this phenomenon results from imbalances between the demands for IRS by fixed-rate payers or receivers from buy-side firms and dealers at CME, Eurex, and LCH (which is in part a function of available but differential and fragmented liquidity) along with the lack of cross-margining across CCPs.¹⁴⁴

85. During the putative Class Period, cross-border CCP recognition could not have been the driver of the Eurex-LCH clearing basis because Eurex and LCH were in the same jurisdiction (*i.e.*, the E.U.). Although Brexit concerns arguably fueled the widening of the Eurex-LCH basis toward the end of the Class Period, market participants did not face significant cross-border regulatory jurisdiction obstacles between Frankfurt and London at the time because all were subject to the same rules and regulations promulgated by the European Securities and Markets Authority ("ESMA").¹⁴⁵

86. Cross-border CCP recognition was also not the driver of the CME-LCH clearing basis during at least part of the Class Period. The E.U. and U.S. reached an accord on the mutual recognition of CCPs for regulatory purposes in March 2016 ("Equivalency Agreement").¹⁴⁶ LCH had been dually registered as an E.U.-regulated CCP *and* a CFTC-regulated designated clearing organization since 2001 and thus was already covered by the Equivalency Agreement.¹⁴⁷ And ESMA formally recognized CME as a CCP pursuant to the Equivalency Agreement effective on

¹⁴⁴ Culp Report, *op. cit.*, at ¶¶299-301. See e.g. R. M. Smith, "CCP Basis Driving CME Clients to LCH, Traders Say," *Risk* (August 12, 2015), F. Maxwell, "CCPs Confront Cleared Swap Basis Threat," *Risk* (August 10, 2015), and E. Benos, W. Huang, A. Menkveld, and M. Vasios, "The Cost of Clearing Fragmentation," *Bank of England Staff Working Paper* No. 800 (May 2019).

¹⁴⁵ Culp Report, *op. cit.*, at ¶307. Note that each country in the E.U. still has its own financial regulator, including the German Federal Financial Supervisory Authority (a.k.a. "BaFin") and the U.K. Financial Conduct Authority ("FCA"). The technical standards and guidelines produced by ESMA, however, are generally accepted and implemented by local regulators – see https://www.bafin.de/EN/RechtRegelungen/Leitlinien_und_Q_and_A_der_ESAs/Leitlinien_und_Q_and_A_der_ESAs_node_en.html (BaFin), and <https://www.esma.europa.eu/convergence/guidelines-and-technical-standards> (ESMA).

¹⁴⁶ Commission Implementing Decision (EU) 2016/377 of 15 March 2016, *Official Journal of the European Union* L 70/32 (March 16, 2016), at <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016D0377&from=EN>, and CFTC, "Comparability Determination for the European Union: Dually-Registered Derivatives Clearing Organizations and Central Counterparties," *Federal Register* Vol. 81, No. 55 (March 22, 2016).

¹⁴⁷ See also CFTC, "No-Action Relief for EU-Based Registered Derivatives Clearing Organizations that are Authorized to Operate in the European Union, from Certain Requirements under Part 22 and Part 39 of Commission Regulations," *CFTC No-Action Letter* No. 16-26 (March 16, 2016).

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June 14, 2016.¹⁴⁸ As shown in my Opening Report, however, the CME-LCH clearing basis was at its highest in 2017, with 2016 exhibiting the second-largest basis – *i.e.*, well after the Equivalency Agreement.¹⁴⁹ The empirical evidence thus indicates that cross-border CCP recognition was not the main driver of the CME-LCH clearing basis.

87. Contrary to Prof. Duffie’s explanation and opinion, the persistent CME-LCH and Eurex-LCH clearing bases during much of the Class Period was not primarily the result of regulation. And regardless of whether the reasons for market fragmentation and/or persistent deviations in prices and spreads were based on differential regulations or not, the two examples I discussed in my Opening Report are nevertheless valid illustrations of *the implications* of liquidity fragmentation.

88. Liquidity bifurcation can also occur across alternative platforms listing the same product but with different rules, costs and fees, and/or execution protocols in the absence of regulatory disparities. The case of gold futures markets in the U.S. is an example, and clearly reflects the concept that market participants may gravitate towards markets in which they expect the best quality, but at the expense of the orphaned market.

89. Gold futures were originally listed for trading by The Commodity Exchange, Inc. (“COMEX”), and until 2004 gold futures were traded using the “open outcry” protocol in physical trading pits, which accounted for about 90 percent of the exchange’s trading volume.^{150,151} In October 2004, the Chicago Board of Trade (“CBOT”) launched a contract identical to COMEX’s gold futures contract with the exception that the CBOT contracts were

¹⁴⁸ CME Clearing, “CME Inc. Receives ESMA Recognition as Third-Country Central Counterparty,” *Advisory Notice* No. 16-231 (June 14, 2016), at <https://www.cmegroup.com/notices/clearing/2016/06/Chadv16-231.html> and <https://www.cmegroup.com/content/dam/cmegroup/notices/clearing/2016/06/Chadv16-231.pdf>. See also European Securities and Markets Authority and U.S. Commodity Futures Trading Commission, *Memorandum of Understanding Related to ESMA’s Assessment of Compliance and Monitoring of the Ongoing Compliance with Recognition Conditions by Derivatives Clearing Organizations Established in the United States* (June 2, 2016), at <https://www.cftc.gov/sites/default/files/idc/groups/public/@internationalaffairs/documents/file/cftc-esma-clearingmou060216.pdf>.

¹⁴⁹ Culp Report, *op. cit.*, at Exhibit V-3.

¹⁵⁰ M. Quint, “Comex and Nymex Reach Accord on Merger Proposal,” *New York Times* (August 21, 1993).

¹⁵¹ COMEX merged with NYMEX in 1994. (See Reuters, “Nymex-Comex Deal Is Set,” *New York Times* (July 22, 1994).) The merged COMEX/NYMEX entity was later acquired by CME in 2008. (See CME, “CME Group Inc. to Acquire NYMEX Holdings, Inc. on Terms Previously Announced,” *Press Release* (March 17, 2008).)

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listed for electronic execution using a CLOB platform.¹⁵² By August 2006, about half of the market share for gold futures had migrated from COMEX's open outcry to CBOT's CLOB.¹⁵³

90. In December 2006, COMEX listed gold futures on CME's Globex platform alongside gold futures contracts that were still available for trading on COMEX through open outcry.¹⁵⁴ After COMEX introduced the gold futures on Globex, volume began to migrate *again* – this time from CBOT's CLOB to CME's CLOB.¹⁵⁵ Ultimately, by 2008 COMEX had regained its liquidity dominance for gold futures through trading activity on Globex.¹⁵⁶

91. As volume and open interest for gold futures declined on the COMEX open outcry platform (which first lost to CBOT's CLOB and later to CME's CLOB), various measures of market quality and liquidity at COMEX's open-outcry pits declined. Those empirical results are consistent with the notion that market participants may gravitate towards markets in which they expect the best quality, but at the expense of the orphaned market.¹⁵⁷ As this example indicates, contrary to the assertions of Profs. Duffie and Grinblatt,¹⁵⁸ not all markets and market participants benefit from wider choice of execution protocols. If market participants adopt a preferred execution venue and trading protocol, participants on the remaining “orphaned” platform are often left worse off.¹⁵⁹

¹⁵² V. Martinez, Z. Ning, and Y. Tse, “Competition for Order Flow and Market Quality in the Gold and Silver Futures Markets,” *The University of Texas at San Antonio, College of Business Working Paper Series* No. 0036FIN-257-2008 (February 12, 2008), at 2.

¹⁵³ Martinez, Ning, and Tse, *op. cit.*, at 2.

¹⁵⁴ Martinez, Ning, and Tse, *op. cit.*, at 2, and COMEX/NYMEX, “NYMEX and COMEX Submission #06.147: Metal Liquidity Provider Program on CME Globex® System,” (December 1, 2006), at <https://www.cftc.gov/sites/default/files/files/submissions/rules/selfcertifications/2006/rul120106nymex-comex001.pdf>.

¹⁵⁵ Martinez, Ning, and Tse, *op. cit.*, at 4-5.

¹⁵⁶ For example, FIA's Monthly Volume Report shows that in January 2009, 353,511 gold futures contracts were transacted at CME's COMEX division, as compared to 170,688 gold futures contracts traded at NYSE LIFFE U.S. (which acquired the CBOT precious metals complex in March 2008).

¹⁵⁷ Note that this example does not necessarily demonstrate that AA2A CLOB execution is inherently better than non-anonymous A2A execution. Electronic trading itself has benefits vis-à-vis pit trading whether or not trading is anonymous – e.g., more widespread access of traders to markets by geography and time zone, 24-hour access to trading venues, elimination of physical constraints on access to trading such pit size limitations, operational efficiencies and facilitating straight-through processing, reduction in trade entry errors and “out-trades,” etc. See, e.g., J. W. Labuszewski and L. Aldinger, “Twenty Years of CME Globex,” *CME White Paper* (June 21, 2012).

¹⁵⁸ Duffie Reply Report, *op. cit.*, at ¶¶62-64, and Grinblatt Reply Report, *op. cit.*, at ¶11.

¹⁵⁹ Martinez, Ning, and Tse, *op. cit.*, at 4-5.

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92. In essence, both Profs. Duffie and Grinblatt try to support their opinions that the introduction of AA2A trading in the but-for IRS world would have made everyone better off by virtue of the increased choices market participants faced. Yet, as volume and open interest shifted first from COMEX's open outcry platform to CBOT's CLOB and then again later from CBOT's CLOB to CME's CLOB, market and liquidity conditions were eventually adversely impacted on the platforms experiencing a flight of volume – whether voice/pit or electronic platforms.¹⁶⁰ In other words, *not* everyone was better off because of the additional choice of a new execution platform. Indeed, Prof. Duffie acknowledges that the introduction of a CLOB in the IRS space would have caused “[l]iquidity in non-standard risks [to] diminish because it is so much more expensive to hold. Reduced liquidity in non-standard risk parameters will oblige dealers to price accordingly, further disinclining clients from transacting these complex structures.”¹⁶¹

93. So, the potential for market fragmentation is an obvious counter-example to Plaintiffs' experts' contention that giving buy-side IRS participants the additional choice of AA2A execution cannot hurt *anyone* in the putative Class. It *can* hurt putative Class Members when the introduction of a new market microstructure or execution platform causes liquidity fragmentation across markets that (for whatever reason – regulatory or otherwise) are not fully integrated. Without individualized inquiries, it is impossible for Plaintiffs' experts to identify which particular putative Class Members would benefit from the added choice and optionality of AA2A execution versus which Class Members would have been harmed in the but-for world during the Class Period.

94. For the aforementioned reasons, Prof. Duffie's admissions about the harms from reduced liquidity for orphaned products are inconsistent with his opinion and Prof. Grinblatt's model (*see* Section V) that spreads would have compressed for *all* IRS that remained off-SEF in the but-for world. Even if “price discipline” had the effect of putting downward pressure on non-SEF IRS spreads, market and liquidity fragmentation would have put pressure on such spreads in the other direction – *i.e.*, to widen in at least some markets – and Prof. Duffie has not

¹⁶⁰ Martinez, Ning, and Tse, *op. cit.*, at 19-20. For a similar situation in a different market, *see* C. Pirrong, “Bund for Glory, or It’s a Long Way to Tip a Market,” *Journal of Applied Corporate Finance* Vol. 27, No. 4 (Fall 2015).

¹⁶¹ Duffie Report, *op. cit.*, at ¶¶134-137.

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provided support for his opinion that the former effect would dominate the latter and that spreads for non-AA2A orphaned products would contract on net.

95. The fact that buy-side customers do not always benefit and sometimes can be harmed when provided with additional options for trading venues undermines Plaintiffs' Spread Propagation theory. I showed in my Opening Report (and indicate again below in Section IV), moreover, that Prof. Grinblatt has also not presented a reliable Class-wide damages model that appropriately accounts for these effects.

(3) Transparency and Liquidity Externalities

96. Plaintiffs and their experts further criticize me for not relying on a 2006 study on corporate bond price transparency that they believe supports their Spread Propagation theory. That study by Bessembinder, Maxwell, and Venkataraman ("BM&V") shows that "transparency on certain bonds reduced spreads on other bonds not subject to the same transparency reporting."¹⁶²

97. As I explained in my deposition, however, I was familiar with and did consider this study, but I did not rely upon it and ultimately concluded that it was not "relevant for the interest rate swap market."¹⁶³ There are important reasons why I did not refer to this study and why Plaintiffs' criticisms are unfounded.

98. First, the BM&V article is based on corporate bond transactions reported through TRACE and thus is limited to prices observed as a result of *post*-trade price transparency. As I indicated in my Opening Report, *post*-trade price transparency was already significantly enhanced by the regulations adopted pursuant to Dodd-Frank.¹⁶⁴ And as recognized by Prof. Duffie, "[the] significant compression in bid-offer spreads for USD IRS was caused by

¹⁶² H. Bessembinder, W. Maxwell and K. Venkataraman, "Market Transparency, Liquidity Externalities, and Institutional Trading Costs in Corporate Bonds," *Journal of Financial Economics* Vol. 82 (2006), and Ptfs MOL ISO Culp Exclusion, *op. cit.*, at 6. *See also* Grinblatt Reply Report, *op. cit.*, at ¶82.

¹⁶³ Culp Dep. Tr., *op. cit.*, at 58:25-59:3.

¹⁶⁴ Culp Report, *op. cit.*, at ¶¶74-78 &106-110.

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improvement in competition and post-trade price transparency associated with regulation-mandated SEF trade.”^{165,166}

99. A second reason that I did not cite or rely on the BM&V paper is that a study by Goldstein, Hotchkiss, and Sirri¹⁶⁷ showed “that less frequently traded bonds and very large trades showed no significant reduction in bid-ask spread with the introduction of public transaction reporting under TRACE.”¹⁶⁸ In other words, even if Plaintiffs’ experts are correct that the BM&V study supports Plaintiffs’ experts’ Spread Propagation theory with regard to some IRS, it does not extend to all IRS that are traded off-SEF and further highlights the individualized nature of the inquiries that would be necessary to determine which IRS would have been affected.

V. PROF. GRINBLATT’S ASSUMPTION OF ARITHMETIC COMPRESSION FOR ESTIMATING DAMAGES ON OFF-SEF AND/OR UNCLEARED TRADES

100. In my Opening Report, I showed that Prof. Grinblatt’s assumption of “arithmetic compression” – which he used in the Grinblatt Report to determine spread compression in the but-for world for all off-SEF and/or uncleared IRS – was flawed and inconsistent with the results of Prof. Grinblatt’s own regression model for estimating spreads in the actual world.¹⁶⁹ Specifically, Prof. Grinblatt assumed that, in the but-for world, all off-SEF and/or uncleared IRS would have experienced at least the same magnitude of basis-point spread compression as on-SEF, cleared trades with similar economic attributes. As I explained in my Opening Report, this assumption implies that, in the actual world: “(a) the magnitude of spread compression observed for off-SEF and/or uncleared transactions should be at least equal to that of on-SEF, cleared transactions with similar attributes (notional, tenor, and trading frequency); and (b) the

¹⁶⁵ Duffie Reply Report, *op. cit.*, at ¶54. *See also* Johannes Report, *op. cit.*, at ¶176.

¹⁶⁶ Plaintiffs’ counsel disagrees with Prof. Duffie and contends that post-trade price transparency had a minimal impact on the IRS market: “The ‘price transparency’ referenced by Dr. Culp is the limited *post-trade* price transparency available on an AA2A platform.” *See* Ptfs MOL ISO Culp Exclusion, *op. cit.*, at 11.

¹⁶⁷ M. A. Goldstein, E. S. Hotchkiss, and E. R. Sirri, “Transparency and Liquidity: A Controlled Experiment on Corporate Bonds,” *Review of Financial Studies* Vol. 20 (2007).

¹⁶⁸ D. Duffie, “Financial Regulatory Reform After the Crisis: An Assessment,” *Management Science* Vol. 64 (2016), at 36.

¹⁶⁹ Culp Report, *op. cit.*, at ¶¶309-324.

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lock-step with spread compression for on-SEF, cleared transactions.”¹⁷⁰ Yet, as I demonstrated, neither of these claims was borne out by Prof. Grinblatt’s initial regression model.

101. For example, as I stated in my Opening Report, the illustrative trade data that Prof. Grinblatt used in Grinblatt Report Table 10 to try and illustrate his assumption of “arithmetic compression” showed that “the actual compression associated with on-SEF, cleared transactions exceeds that for similar off-SEF or non-cleared transactions, and that the compression rates for different types of swaps do not move together.”¹⁷¹ Those data thus directly contradict Prof. Grinblatt’s assumption and undermine his claim in the Grinblatt Report that his assumption of arithmetic compression is “conservative.”¹⁷²

102. In his Reply Report, Prof. Grinblatt ignores the significant flaws and inconsistencies that I identified in connection with his arithmetic compression assumption and includes only two paragraphs defending it.¹⁷³ In those two paragraphs, he vaguely contends that “the results of the refined regression model” he presents in Section VI.B of his Reply Report “support [his] adoption of arithmetic compression.”¹⁷⁴ Prof. Grinblatt also restates his arithmetic-compression assumption: “For transactions that were off-SEF, uncleared or both, I adopted a conservative principle I termed ‘arithmetic compression,’ i.e. that ‘the magnitude of the spread compression experienced by these transactions in basis points will be no less than the magnitude of basis point spread compression applicable to an on-SEF, cleared transaction with the same economic attributes.’”¹⁷⁵ He claims that “[t]he coefficients of this regression model, presented in Table VI.3, demonstrate...[and provide] empirical support for the principle of arithmetic compression under which I establish damages for transactions in categories other than on-SEF and cleared.”¹⁷⁶

103. Among other things, Prof. Grinblatt’s revised model estimates different spreads for IRS in which a customer pays a fixed interest rate (*i.e.*, “payer” trades) and trades in which the

¹⁷⁰ Culp Report, *op. cit.*, at ¶311.

¹⁷¹ Culp Report, *op. cit.*, at ¶311. *See also* Culp Report, *op. cit.*, at ¶¶312-13 & Exhibit V-4.

¹⁷² Culp Report, *op. cit.*, at ¶314-15.

¹⁷³ Grinblatt Reply Report, *op. cit.*, at ¶¶364-65.

¹⁷⁴ Grinblatt Reply Report, *op. cit.*, at ¶365.

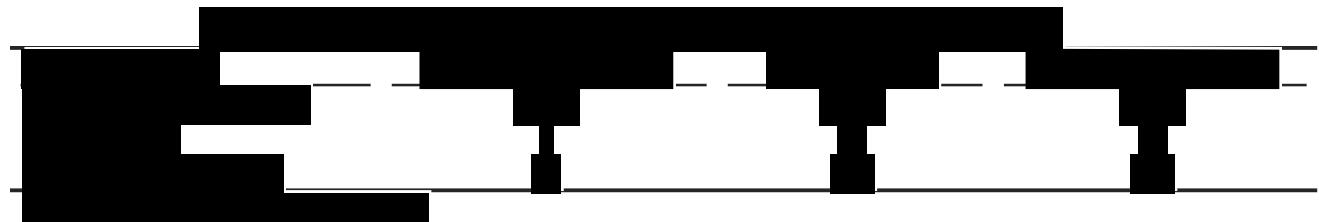
¹⁷⁵ Grinblatt Reply Report, *op. cit.*, at ¶364.

¹⁷⁶ Grinblatt Reply Report, *op. cit.*, at ¶365.

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103. Among other things, Prof. Grinblatt's revised model estimates different spreads for IRS in which a customer pays a fixed interest rate (*i.e.*, “payer” trades) and trades in which the customer receives a fixed interest rate (*i.e.*, “receiver” trades).¹⁷⁷ In Panel A of the Grinblatt Reply Report Table VI.3 (“Incremental Spread Coefficients by Year, Relative to 2017 by SEF-Trading, & Clearing”), he presents his estimated coefficients for payer trades for four categories of IRS: (i) on-SEF/cleared; (ii) on-SEF/uncleared; (iii) off-SEF/cleared; and (iv) off-SEF/uncleared. He also includes for each payer coefficient an “adjustment for receiver,” which can be subtracted from the payer coefficient to calculate the receiver coefficient.

104. Like Prof. Grinblatt's initial regression model and the data presented in Grinblatt Report Table 10, Prof. Grinblatt's revised regression model presented in Grinblatt Reply Report Table VI.3 undermines, rather than supports, his assumption of arithmetic compression. As I explain below, when the revised regression model is applied to Prof. Grinblatt's three illustrative trades which he defines as trades with notional, tenor, and trading frequency at the 25th percentile, median, and 75th percentile of the range of trades in his sample, the results contradict his arithmetic-compression assumption.¹⁷⁸ I summarize the trade attributes for the three illustrative trades as defined by Prof. Grinblatt in Table V-1.



105. Using Prof. Grinblatt's revised regression model presented in the Grinblatt Reply Report Table VI.3, I have estimated the actual spreads for each year between 2013/2014¹⁸⁰ and 2017 on IRS with the attributes of Prof. Grinblatt's three illustrative trades (as set out in Table V-1) in each of the four categories of IRS: (i) on-SEF/cleared; (ii) on-SEF/uncleared; (iii) off-

¹⁷⁷ Grinblatt Reply Report, *op. cit.*, at ¶413.

¹⁷⁸ Grinblatt Report, *op. cit.*, at ¶244 & Table 7.

¹⁷⁹ Grinblatt Report, *op. cit.*, at Table 7.

¹⁸⁰ To mirror Prof. Grinblatt's initial and revised regression model, I have “pooled the data for 2013 and 2014” and estimated spreads “under the premise that the coefficients of relationship in late 2013 was the same as in 2014.” Grinblatt Report, *op. cit.*, at ¶239. *See also* Grinblatt Reply Report, *op. cit.*, ¶414 fn597.

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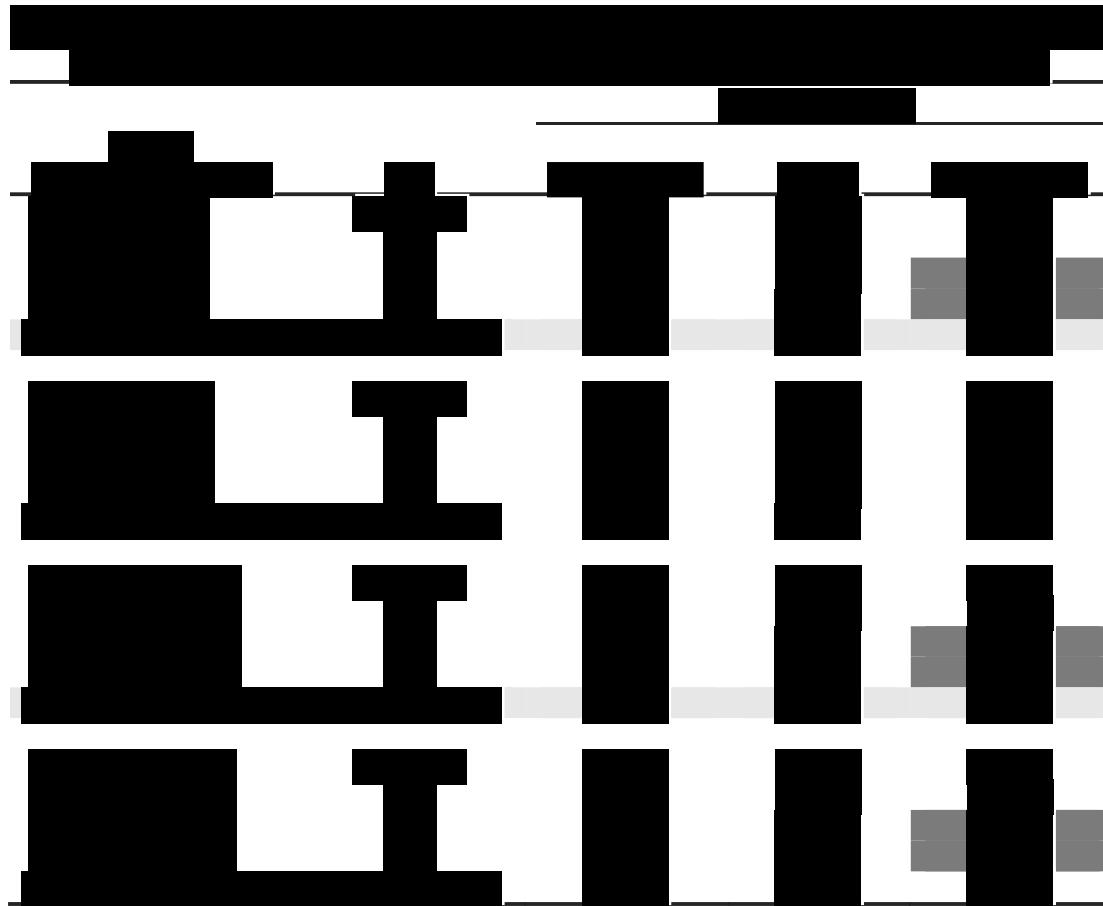
SEF/cleared; and (iv) off-SEF/uncleared. I summarize these results for IRS in which the customer is receiving the fixed rate in Table V-2 and for IRS in which the customer is paying the fixed rate in Table V-3. In both Tables V-2 and V-3, I also show the magnitude of spread compression in Prof. Grinblatt's "actual" world between 2013/2014 and 2017 for the three illustrative trades in each of the four categories of IRS.

106. Like Prof. Grinblatt's initial regression model and the data presented in Table 10 of his initial report, Prof. Grinblatt's revised regression model contradicts his proposed assumption of arithmetic compression. Looking first at the receiver trades presented in Table V-2 below, as shown in yellow highlighting, Prof. Grinblatt's illustrative uncleared IRS (both on-SEF and off-SEF) experienced *less* basis-point spread compression in the "actual" world from 2013/2014-2017 than his equivalent on-SEF, cleared trades.

107. Table V-3 shows similar results for Prof. Grinblatt's illustrative payer trades. As shown in yellow highlighting, all three of Prof. Grinblatt's illustrative off-SEF, uncleared IRS

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experienced *less* basis-point spread compression in the “actual” world between 2013/2014 and 2017 than Prof. Grinblatt’s equivalent on-SEF, cleared IRS.



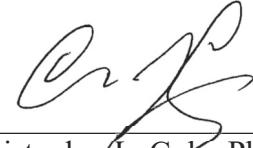
108. The results in Tables V-2 and V-3 directly contradict Prof. Grinblatt’s assumption of arithmetic compression and undermine the sole defense of that assumption that he puts forward in his Reply Report. Indeed, as I have demonstrated, Prof. Grinblatt’s assumption of arithmetic compression fails with respect to *half* of his own off-SEF and/or uncleared illustrative receiver and payer trades.

109. As I explained in my Opening Report, moreover, if Prof. Grinblatt’s assumption of arithmetic compression is correct, then the magnitude of spread compression for off-SEF and/or uncleared transactions should consistently move in lock-step with spread compression for on-SEF, cleared transactions.¹⁸¹ Yet this is not the case. For example, as shown in red highlighting

¹⁸¹ Culp Report, *op. cit.*, at ¶313.

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in Tables V-2 and V-3, spreads for Prof. Grinblatt's 75th percentile illustrative on-SEF, cleared trade *tightened* in 2017 relative to 2016, but spreads for the equivalent on-SEF, uncleared and off-SEF, uncleared trades *widened* during the same time period.



Christopher L. Culp, Ph.D.
November 27, 2019

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APPENDIX A: CURRICULUM VITAE OF CHRISTOPHER L. CULP, PH.D.

NOVEMBER 2019

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AREAS OF SPECIALIZATION

Derivatives	Credit Risk and Fixed Income
Structured Finance	Financial Instrument Valuation
Insurance/Reinsurance/Structured Insurance	Clearing and Settlement
Foreign Exchange	Risk Management/Measurement
Commodities (softs, oil & gas, power, weather)	

EDUCATION

1997	<i>Ph.D., Finance</i> , The University of Chicago, Graduate (now Booth) School of Business <i>Thesis Committee:</i> M. H. Miller (chair), J. H. Cochrane, O. A. Lamont, J. A. Scheinkman
1990	<i>B.A., Economics</i> , The Johns Hopkins University General and Departmental Honors, Phi Beta Kappa

PROFESSIONAL EXPERIENCE

Employment:

1994 – 1997 & 2003 – Present	<i>Financial Economics Consulting, Inc. (f/k/a Risk Management Consulting Services, Inc.)</i> Managing Director
1997 – 2003	<i>Chicago Partners LLC</i> Principal (1998-2003) Managing Director of CP Risk Management (1998-2003) Vice President (1997)
1993 – 1994	<i>Federal Reserve Bank of Chicago, Supervision and Regulation Department, Financial Markets Unit</i> Administrative Examiner (1994) Senior Examiner (1993-1994)
1992 – 1993	<i>TradeLink LLC</i> Futures and Options Trading Strategist (commodities and currencies)

Other Professional and Board Affiliations:

2006 – Present	<i>Compass Lexecon</i> Senior Affiliate
2002 – 2005	<i>IDACORP, Inc., and Idaho Power Company</i> Independent Non-Executive Board Member and Director Member of the Board Audit Committee Member of the Board Governance Committee

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2001 – 2002	<i>@Markets Association (an affiliate of the Futures Industry Association)</i> Public Director
1991	<i>G.T. Management (Asia) Ltd. (a subsidiary of LGT Bank in Liechtenstein)</i> (Hong Kong) Research Fellow

PUBLICATIONS AND RESEARCH (SINCE 1990)Books:

2018, *Credit Default Swaps: Mechanics and Empirical Evidence on Benefits, Costs, and Inter-market Relations* (New York, N.Y.: Palgrave Macmillan) – with A. van der Merwe and B. J. Stärkle

2006, *Structured Finance & Insurance: The ART of Managing Capital and Risk* (Hoboken, N.J.: John Wiley & Sons)

2004, *Risk Transfer: Derivatives in Theory and Practice* (Hoboken, N.J.: John Wiley & Sons)

2003, Co-Editor, *Corporate Aftershock: The Public Policy Lessons from the Collapse of Enron and Other Major Corporations* (Hoboken, N.J.: John Wiley & Sons) – with W. A. Niskanen

2002, *The ART of Risk Management: Alternative Risk Transfer, Capital Structure, and the Convergence of Insurance and Capital Markets* (Hoboken, N.J.: John Wiley & Sons)

2001, *The Risk Management Process: Business Strategy and Tactics* (Hoboken, N.J.: John Wiley & Sons)

1999, Co-Editor, *Corporate Hedging in Theory and Practice: Lessons from Metallgesellschaft* (London: Risk Books) – with M. H. Miller

Current Working Papers:

2018, “Option-Implied Spreads” (December) – with Y. Nozawa and P. Veronesi

2018, “A Review of the Academic Literature on the Causes and Evolution of the Credit Crisis,” *Johns Hopkins Institute for Applied Economics, Global Health, and the Study of Business Enterprise – Studies in Applied Finance* No. 24 (April)

Published Articles and Studies:

2018, “Option-Based Credit Spreads,” *American Economic Review* Vol. 108, No. 2 (February) – with Y. Nozawa and P. Veronesi – first-prize winner of the 2015 AQR Insight Award

2017, “Shadow Banking, Risk Transfer, and Financial Stability,” *Journal of Applied Corporate Finance* Vol. 29, No. 4 (Fall) – with A. M. P. Neves

2016, “Single-Name Credit Default Swaps: A Review of the Empirical Academic Literature,” *International Swaps and Derivatives Association Study and Johns Hopkins Institute for Applied Economics, Studies in Applied Finance* No. 11 (September) – with A. van der Merwe and B. J. Stärkle

2015, “Potential Regulatory Impacts on CLOs,” *BNA’s Banking Report* (September 14) – with J. P. Forrester

2015, “Risks to Investors in Senior CLO Tranches,” *BNA’s Banking Report* (August 31) – with J. P. Forrester

2015, “Post-Crisis Developments in U.S. Leveraged Loans and CLOs,” *BNA’s Banking Report* (August 24) – with J. P. Forrester

2015, “Have Pre-Crisis Levels of Risk Returned in U.S. Structured Products? Evidence from U.S. Subprime Auto ABS, CLOs, and Insurance-Linked Securities Markets,” *Journal of Structured Finance* Vol. 21, No. 1 (Spring) – with J. P. Forrester

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2013, "Customer Asset Protection Insurance," *Compass Lexecon Study for CME Group, Futures Industry Association, Institute for Financial Markets, and National Futures Association* (November)

2013, "The Hong Kong Linked Rate Mechanism: Monetary Lessons for Economic Development," *Johns Hopkins Institute for Applied Economics, Studies in Applied Economics* No. 6 (June) – with S. H. Hanke

2013, "Syndicated Leveraged Loans During and After the Crisis and the Role of the Shadow Banking System," *Journal of Applied Corporate Finance* Vol. 25, No. 2 (Spring)

2013, "U.S. Structured Finance Markets: Recent Recoveries, Post-Crisis Developments, and Ongoing Regulatory Uncertainties," *Journal of Structured Finance* Vol. 18, No. 4 (Winter) – with J. P. Forrester

2012, "Recent Developments and Regulatory Uncertainties in the U.S. Structured Finance Market," *Cayman Financial Review* No. 29 – with J. P. Forrester

2010, "Financial Transaction Taxes: Benefits and Costs," *Compass Lexecon Study for Virtu Management LLC* (March)

2010, "Financial Transaction Taxes: The Issues and the Evidence," *Cayman Financial Review* No. 20

2010, "OTC-Cleared Derivatives: Benefits, Costs, and Implications of the 'Dodd-Frank Wall Street Reform and Consumer Protection Act,'" *Journal of Applied Finance* No. 2

2010, "The Shape of CDOs to Come," *Cayman Financial Review* No. 18 – with J. P. Forrester

2009, "Catastrophe Reinsurance and Risk Capital in the Wake of the Credit Crisis," *Journal of Risk Finance* Vol. 10, No. 5 – with K. J. O'Donnell

2009, "Contingent Capital vs. Contingent Reverse Convertibles for Banks and Insurance Companies," *Journal of Applied Corporate Finance* Vol. 21, No. 4 (Fall)

2009, "Statement of Christopher L. Culp on 'The Effective Regulation of Over-the-Counter Derivatives Markets,'" *U.S. House of Representatives, Committee on Financial Services, Subcommittee on Capital Markets, Insurance, and Government-Sponsored Enterprises, 111th Congress, First Session – Serial No. 111-41* (June 9, 2009)

2008, "Reinsurance and Risk Capital," *Renaissance Re Holdings Ltd. Study* (December) – with K. J. O'Donnell

2008, "The Economics of Naked Short Selling," *Regulation* (Spring) – with J. B. Heaton

2005, "The Uses and Abuses of Finite Risk Reinsurance," *Journal of Applied Corporate Finance* Vol. 17, No. 3 (Summer) – with J. B. Heaton; reprinted in *Corporate Risk Management*, D. H. Chew, ed. (New York, N.Y.: Columbia University Press, 2008)

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2001, "The Risk Management Value Proposition," *@Markets Magazine* Vol. 1, No. 3 (May/June)

2000, "Ex Ante vs. Ex Post RAROC," *Derivatives Quarterly* Vol. 7, No. 1 (Fall)

2000, "New Risk Culture: An Opportunity for Business Growth and Innovation," *Derivatives Quarterly* Vol. 6, No. 4 (Summer) – with P. Planchat

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2000, "RAROC Revisited: Ex Ante vs. Ex Post RAROC," *Journal of Lending & Credit Risk Management* (March)

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1999, "A Primer on Securities and Multi-Currency Settlement Systems: Systemic Risk and Risk Management," *Competitive Enterprise Institute White Paper* (June) – with A. M. P. Neves

1999, "Measuring Risk for Asset Allocation, Performance Evaluation, and Risk Control: Different Problems, Different Solutions," *Journal of Performance Measurement* (Fall) – with R. Mensink; reprinted in *The Handbook of Risk*, B. Hardwick, ed. (Hoboken, N.J.: John Wiley & Sons, 2003)

1998, "Credit and Interest Rate Risk in the Business of Banking," *Derivatives Quarterly* Vol. 4, No. 4 (Summer) – with A. M. P. Neves

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1998, "Value at Risk for Asset Managers," *Derivatives Quarterly* Vol. 5, No. 2 (Winter) – with R. Mensink and A. M. P. Neves; reprinted in *Global Investment Risk Management*, E. Zask, ed. (New York, N.Y.: McGraw-Hill, 2000)

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1994, "Methods of Resolving Over-the-Counter Derivatives Contracts in Failed Depository Institutions: Restrictions on Regulators from Federal Banking Law," *Futures International Law Letter* Vol. 14, Nos. 3-4 (May/June) – with B. T. Kavanagh

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2008, "Risk and Risk Management," in *Handbook of Finance, Vol. III: Valuation, Financial Modeling, and Quantitative Tools*, F. J. Fabozzi, ed. (Hoboken, N.J.: John Wiley & Sons)

2004, "Alternative Risk Transfer," in *Risk Management: Challenge and Opportunity*, 2nd ed., M. Frenkel, U. Hommel, and M. Rudolf, eds. (Berlin: Springer-Verlag)

2003, "Credit Risk Management Lessons from Enron," in *Corporate Aftershock: The Public Policy Lessons from the Collapse of Enron and Other Major Corporations*, C. L. Culp and W. A. Niskanen, eds. (Hoboken, N.J.: John Wiley & Sons)

2003, "Equilibrium Asset Pricing and Discount Factors: Overview and Implications for Derivatives Valuation and Risk Management," in *Modern Risk Management: A History*, P. Field, ed. (London: Risk Books) – with J. H. Cochrane

2003, "Empire of the Sun: A Neo-Austrian Economic Interpretation of Enron's Energy Business," in *Corporate Aftershock: The Public Policy Lessons from the Collapse of Enron and Other Major Corporations*, C. L. Culp and W. A. Niskanen, eds. (Hoboken, N.J.: John Wiley & Sons) – with S. H. Hanke

2003, "Metallgesellschaft," in *Modern Risk Management: A History*, P. Field, ed. (London: Risk Books)

2003, "The Modigliani-Miller Propositions," in *Modern Risk Management: A History*, P. Field, ed. (London: Risk Books)

2003, "Playing the Odds," in *Risk, Control, and Performance* (New York, N.Y.: McKinsey & Co. for the World Economic Forum)

2003, "Structured Commodity Finance After Enron: Uses and Abuses of Prepaid Forwards and Swaps," in *Corporate Aftershock: The Public Policy Lessons from the Collapse of Enron and Other Major Corporations*, C. L. Culp and W. A. Niskanen, eds. (Hoboken, N.J.: John Wiley & Sons) – with B. T. Kavanagh

2002, "Contingent Capital and the Art of Corporate Finance," in *Alternative Risk Strategies*, M. N. Lane, ed. (London: Risk Books)

2002, "A Formal Approach in a Risky Business," in *Mastering Investments*, J. Pickford, ed. (London: Financial Times Prentice Hall)

1997, "Functional and Institutional Interaction, Regulatory Uncertainty, and the Economics of Derivatives Regulation," in *Derivatives Handbook: Risk Management and Control*, R. J. Schwartz and C. W. Smith, Jr., eds. (Hoboken, N.J.: John Wiley & Sons)

1996, "An Overview of Derivatives: Their Mechanics, Participants, Scope of Activity, and Benefits," in *The Financial Services Revolution*, C. Kirsch, ed. (Chicago, Ill.: Irwin Professional Publishing) – with J. A. Overdahl

1996, "Structured Notes: Mechanics, Benefits, and Risks," in *Derivatives Risk and Responsibility*, R. A. Klein and J. Lederman, eds. (Chicago, Ill.: Irwin Professional Publishing) – with R. J. Mackay

1994, "Managing Derivatives Risk: A Strategic Guide," in *Handbook of Business Strategy* (New York, N.Y.: Faulkner & Gray) – with R. J. Mackay

1992, "Inflation Hedging with Unleveraged Futures," in *Managed Futures in the Institutional Portfolio*. C. Epstein, ed. (Hoboken, N.J.: John Wiley & Sons) – with S. H. Hanke

1992, "Sacred Cows: The Bovine Somatotropin Controversy," in *Environmental Politics: Public Costs, Private Rewards*, M. S. Greve and F. L. Smith, Jr., eds. (New York, N.Y.: Praeger Publishers)

Other Publications:

2003, "Derivate können Unternehmensrisiken begrenzen," *Financial Times Deutschland* (August 15)

2003, "Derivatives Can Help Manage Risks," *Financial Times* (August 11)

2002, "Risk Management Challenges in Electricity Trading, Clearing, and Settlement," *Marsh Portal* No. 7 (September)

HIGHLY CONFIDENTIAL

2001, "Risk Management: A Formal Approach in a Risky Business," *Financial Times* (June 11)

2001, "The Use and Abuse of Derivatives," *Financial Times* (May 14)

2001, "Real Options: A Case Study and Primer," *Derivatives Week* (May 13)

1999, "Wettbewerbsnachteile für Schweizer Banken? Konsultativpapier des Basler Ausschusses mit Schwächen," *Neue Zürcher Zeitung* (October 15)

1999, "A Review of Worldwide Asset and Liability Modeling," *Financial Engineering News* No. 10 (June)

1998, "Use and Misuse of a Risk Management Tool," *Pensions & Investments* Vol. 26, No. 17 (August 24) – with R. Mensink

1997, "A Review of *The US Power Market: Restructuring and Risk Management*," *Risk* Vol. 10, No. 9 (September) – with A. M. P. Neves

1996, "Are Financial Regulations Worth the Cost?" *MFA Reporter* (July)

1996, "The SEC's Costly Disclosure Rules," *Wall Street Journal* (June 22) – with M. H. Miller

1995, "Why the CFTC Is An Anachronism," *Wall Street Journal* (September 5) – with M. H. Miller

1995, "Rein in the CFTC," *Wall Street Journal* (August 17) – with M. H. Miller

1995, "Blame Mismanagement, Not Speculation, for Metall's Woes," *European Wall Street Journal* (April 25) – with M. H. Miller

1995, "Derivatives: A Lesson from *60 Minutes*," *MediaNomics* Vol. 3, No. 3 (April)

1994, "A Hidden Threat Lurks in Derivatives Legislation," *American Banker* (June 16)

1992, "Small Farmers Have Regulators Cowed," *Wall Street Journal* (September 2)

1991, "If Hong Kong's Banks Are Broken, Let the Market Fix Them," *Asian Wall Street Journal* (September 3)

1990, "The Perils of ERM," *Wall Street Journal* (August 24)

1990, "The New Luddites Fight Cheaper Milk," *Newsday* (July 5)

ACADEMIC APPOINTMENTS AND PUBLIC POLICY AFFILIATIONS

2017 – Present *Federal Reserve Bank of Chicago Working Group on Financial Markets*
 Member

2014 – Present *The Johns Hopkins University – Institute for Applied Economics, Global Health, and the Study of Business Enterprise*
 Research Fellow (2014-Present) (<https://sites.krieger.jhu.edu/iae/about/fellows/>)
 Co-Editor of the *Studies in Applied Finance* Working Paper Series (2018-Present) (<https://sites.krieger.jhu.edu/iae/working-papers/studies-in-applied-finance/>)

2001 – Present *Universität Bern – Institut für Finanzmanagement*
 Honorarprofessor/Adjunct Professor (2005-Present) (http://www.ifm.unibe.ch/about_us/people/prof_dr_culp_christopher/)
 Lecturer (2001-2005)

2015 – 2019 *Swiss Finance Institute* (Zürich and Genève)
 Adjunct Professor

2009 – 2014 *Université de Genève – Faculté des Sciences Economiques et Sociales, Section des Hautes Études Commerciales* (Genève)
 Visiting Professor

1988 – 2014 *Competitive Enterprise Institute* (Washington, D.C.)
 Adjunct Fellow in Financial Regulation (2009-2014)
 Senior Fellow in Financial Regulation (1994-2008)

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	Adjunct Policy Analyst (1990-1994) Associate Policy Analyst (1988-1990)
1998 – 2013	<i>The University of Chicago, Booth School of Business</i> Adjunct Professor of Finance (2003-2013) Adjunct Associate Professor of Finance (1998-2003)
2004 – 2006	<i>Universität Basel – Wirtschaftswissenschaftliches Zentrum, Abteilung Finanzmarkttheorie</i> Visiting Professor

TEACHING EXPERIENCE AND STUDENT RESEARCH SUPERVISION**Graduate University Courses Taught:**

2002 – 2015, “The Theory and Practice of Insurance,” *Universität Bern*
 2003 – 2013, “Structured Finance and Insurance,” *Chicago Booth*
 2009 – 2012, “Hedging Tools and Techniques Using Commodity Futures, Forwards, & Swaps,” *Université de Genève*
 1998 – 2009, “Futures, Forwards, Options, and Swaps: Theory & Practice,” *Chicago Booth*
 2002 – 2007, “Introduction to Financial Instruments,” *Chicago Booth*
 2005 – 2006, “Structured Finance and Alternative Risk Transfer,” *Universität Basel*
 2003, “Investments,” *Chicago Booth*

Executive Education Courses Taught:

July 2008, “Risk, Capital, and Reinsurance Underwriting: Part II,” *RenaissanceRe Holdings Ltd.* (Bermuda)
 March 2008, “Credit: Insurance, Derivatives, and Crisis,” *Institut für Finanzmanagement der Fachhochschule Nordwestschweiz* (Zürich) – with D. Imfeld
 September 2007, “Risk, Capital, and Reinsurance Underwriting: Part I,” *RenaissanceRe Holdings Ltd.* (Bermuda)
 August 2007, “Risk Management: Revolution or Evolution?” *Chicago Booth & Seminarium* (Chicago)
 July 2007, “Risk Management: Revolution or Evolution?” *Chicago Booth & Seminarium* (Santiago)
 July 2006, “Corporation Finance and Risk Management,” *Chicago Booth & Instituto de Empresa Madrid* (London)
 February 2006, “The ART of Risk Management, Enterprise-Wide Risk Management, and the Value of Traditional and Alternative Risk Transfer to Large Corporations,” *Institut für Finanzmanagement der Fachhochschule Nordwestschweiz* (Zürich) – with D. Imfeld
 October 2005, “Risk Management and Governance,” *Chicago Booth & Seminarium* (Chicago)
 July 2005, “Corporation Finance and Risk Management,” *Chicago Booth & Instituto de Empresa Madrid* (Barcelona)
 May 2005, “Risk and Capital Management,” *Chicago Booth & Swiss Re Financial Services* (Chicago)
 April 2005, “Alternative Risk Transfer: The Convergence of Corporate Finance and Risk Management,” *Chicago Booth* (Chicago) – with J. P. Forrester and B. T. Kavanagh
 March 2005, “Introduction to Futures Markets for Executives,” *Chicago Booth & Agricultural Futures Exchange of Thailand* (Bangkok) – with G. Burghardt
 October 2004, “Risk and Capital Management,” *Chicago Booth & Swiss Re Financial Services* (Chicago)
 June 2004, “Risk Management and the Board of Directors,” *Chicago Booth & Motorola University Chinese Corporate Governance Program* (Chicago)

HIGHLY CONFIDENTIAL

May 2004, "Risk and Capital Management," *Swiss Re Financial Services* (Santa Clara)

April 2004, "Alternative Risk Transfer: The Convergence of Corporate Finance and Risk Management," *Chicago Booth* (Chicago)

March 2004, "Portfolio Management," *Chicago Booth & Abu Dhabi Investment Authority* (Abu Dhabi) – with H. Zimmermann

October 2003, "Alternative Risk Transfer: The Convergence of Corporate Finance and Risk Management," *Chicago Booth* (Chicago)

September 2003, "Risk Management for Institutional Investors," *Chicago Booth & Abu Dhabi Investment Authority* (Abu Dhabi)

April 2003, "Alternative Risk Transfer: The Convergence of Corporate Finance and Risk Management," *Chicago Booth* (Chicago)

February 2003, "Alternative Risk Transfer: The Convergence of Corporate Finance and Risk Management," *Chicago Booth & Swiss Re Financial Services* (Barcelona)

November 2002, "Risk Management: Business Strategy and Tactics," *Chicago Booth* (Chicago) – with A. M. P. Neves

November 2002, "Alternative Risk Transfer: The Convergence of Corporate Finance and Risk Management," *Chicago Booth* (Chicago)

May 2002, "Risk Management," *Chicago Booth* (Chicago) – with A. M. P. Neves

November 2001, "Risk Management," *Chicago Booth* (Chicago) – with G. Burghardt and A. M. P. Neves

May 2001, "Risk Management," *Chicago Booth* (Chicago) – with G. Burghardt and A. M. P. Neves

November 2000, "Risk Management," *Chicago Booth* (Chicago) – with G. Burghardt and A. M. P. Neves

April 2000, "Risk Management: Everything You Always Wanted to Know Derivatives and Risk Management But Are Afraid to Ask," *Chicago Booth* (Chicago) – with G. Burghardt and A. M. P. Neves

M.A./M.Sc. Student Theses Supervised:

2016 – Bettina J. Stärkle, "The Effect of Weather Risk Management on Firm Value: An Empirical Comparison of Renewable and Finite Energy Producers," *Universität Bern – M.Sc., Accounting and Finance*

2014 – Yohan Kakon-Cazes, "Volatility Trading on Crude Options," *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

2013 – Milena Thöni, "Minimizing Dry Bulk Freight Rates and Their Volatility from the Perspective of a Dry Bulk Commodity Trading Company," *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

2012 – Irina Bugdaeva, "Basel III and Its Impacts on Commodity Trade Finance," *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

2012 – Jean-Christophe Manghardt, "Securitization and Commodities," *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

2012 – Francois Moncheur, "Minimizing Price Distortion by Hedging the Crack Spread," *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

2011 – Marc Saban, "Speculation and State Intervention on Soft Commodity Markets: the Chicken or the Egg?" *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

2011 – Jeremy Willi, "Commodities and Strategic Allocation: Analysis of Passive Investments in Commodity Futures Indices," *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

HIGHLY CONFIDENTIAL

2010 – Marc-André Erb, “Traditional Basis Theory, Volatility and Mean Reversion: Theory and Empirical Analysis on U.S. Coal Forward Curves Behavior,” *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

2010 – Laura Tolub, “European Power Prices: A Fundamental Analysis,” *Université de Genève – M.A., International Trading, Commodity Finance and Shipping*

JOURNAL EDITORIAL ADVISORY BOARD MEMBERSHIPS

2006 – Present, *Journal of Structured Finance*

2002 – Present, *Journal of Applied Corporate Finance*

2002 – 2015, *Futures Industry*

2002 – 2013, *Journal of Risk Finance*

2002 – 2010, *FMA Online*

1996 – 2000, *Derivatives Quarterly* – Co-Managing Editor (1998-2000)

PRESENTATIONS AND SPEECHES

June 5, 2018, “To Hedge or Not to Hedge? Applications to Weather Risk” (Keynote Speaker), *Swiss Re 8th Annual Weather and Energy Conference* (Munich)

April 5, 2018, “The Dodd-Frank Title VII Clearing Mandate: False Hopes and Undelivered Promises?” *Competitive Enterprise Institute Luncheon* (New York)

November 16, 2016, “Too Big to Fail – Central Counterparties” (Panelist), *SEC Historical Society* (Washington, D.C.) – with C. Lewis, P. Parkinson, and P. Wallison

November 1, 2016, “Single-Name Credit Default Swaps and the Empirical Academic Literature” (Panelist), *International Swaps and Derivatives Association Seminar: Credit Default Swaps – Misconceptions, Generalizations, and What We Actually Need to Know* (New York)

April 8, 2016, “Market Liquidity and Liquidity Risks: Post-Crisis Developments, Hazards, and Opportunities,” *Swiss Finance Institute Wealth Management Retreat* (Zürich) – with A. van der Merwe

November 30, 2015, “Credit Derivatives and Collateralized Loan Obligations,” *Northwestern University School of Law ‘Derivatives: Uses, Abuses, and Regulation’ Class* (Chicago)

December 1, 2014, “Credit Derivatives and Synthetic Default Protection,” *Northwestern University School of Law ‘Derivatives: Uses, Abuses, and Regulation’ Class* (Chicago)

November 6, 2014, “Dodd-Frank, Derivatives and Structured Finance” (Panelist), *SEC Historical Society* (Washington, D.C.) – with J. Kravitt, C. Lewis, and J. Overdahl

September 29, 2014, “Fellow Customer Risk,” *Futures Industry Association/Institute for Financial Markets – Markets Academy Customer Series* (Chicago)

July 2, 2014, “Structured Finance: Will There Be a Revival?” *Swiss Finance Institute – Evening Seminar* (Zürich)

June 19, 2014, “After-Dinner Comments,” *Competitive Enterprise Institute – 30th Anniversary Annual Dinner* (Washington, D.C.)

April 9, 2014, “The Social Benefits of Derivatives,” *29th Annual General Meeting of the International Swaps and Derivatives Association* (Munich)

December 2, 2013, “Synthetic Credit Default Protection Products,” *Northwestern University School of Law ‘Derivatives: Uses, Abuses, and Regulation’ Class* (Chicago)

November 21, 2013, “Customer Asset Protection Insurance,” *Presentation to U. S. Senate Agriculture Committee Staff* (Washington, D.C.)

HIGHLY CONFIDENTIAL

November 21, 2013, "Customer Asset Protection Insurance," *Presentation to U. S. House of Representatives Agriculture Committee Staff* (Washington, D.C.)

November 6, 2013, "Has the Futures Industry Delivered on Enhanced Customer Asset Protection?" (Panelist), *Futures Industry Expo* (Chicago)

December 3, 2012, "Credit Derivatives and Synthetic Securitizations: Mechanics, Post-Crisis Developments, and Pending Regulatory Issues," *Northwestern University School of Law 'Derivatives: Uses, Abuses, and Regulation' Class* (Chicago)

May 1, 2012, "The Future of Structured Finance," *10th Annual Offshore Alert Financial Due Diligence Conference* (Miami Beach)

November 28, 2011, "Credit Derivatives and Synthetic ABS CDOs," *Northwestern University School of Law 'Derivatives: Uses, Abuses, and Regulation' Class* (Chicago)

April 14, 2011, "Wall Street, Fleet Street, and the Ivory Tower" (Panelist), *26th Annual General Meeting of the International Swaps and Derivatives Association* – (Prague)

November 23, 2010, "Derivatives In and After the Crisis," *Northwestern University School of Law 'Derivatives: Uses, Abuses, and Regulation' Class* (Chicago)

April 29, 2010, "Recent Developments in Structured Credit Markets," *The University of Chicago Booth School of Business Management Conference* (Chicago)

April 22, 2010, "Lessons from the Financial Crisis" (Panel Moderator), *25th Annual General Meeting of the International Swaps and Derivatives Association* (San Francisco)

April 12, 2010, "The Impending Sovereign Debt Crisis, the Return of the Leveraged Loan Market, and Implications for the Cayman Islands," *Stuarts Walker Hersant and RBC Wealth Management Seminar* (Grand Cayman)

November 24, 2009, "OTC Derivatives Clearing: Economic Benefits and Costs," *Citadel Investment Group* (Chicago)

September 10, 2009, "Looking Past the Credit Crisis Toward the Future of Derivatives and Structured Finance," *Rochester-Bern Executive MBA Program Luncheon* (Zürich)

April 23, 2009, "A Primer on Debt Products," *American College of Investment Counsel Spring Investment Forum* (Chicago) – with A. S. Kramer

November 13, 2008, "The Financial Crisis and its Aftermath," *Professional Risk Managers' International Association (Chicago Chapter)* (Chicago)

June 5, 2008, "Catastrophic Risk & Risk Capital," *Measuring and Managing Catastrophic Risk: 2nd Annual Chicago Actuarial Association/Midwest Actuarial Forum/Professional Risk Managers' International Association Joint Conference on Enterprise Risk Management* (Chicago)

April 14, 2008, "Structured Finance & Structured Insurance: Perspectives for Offshore Issuers and Investors," *6th Offshore Alert Financial Due Diligence Conference* (Ft. Lauderdale)

March 6, 2008, "Super-Senior AAA CDOs and Other Derivatives Debacles," *Global Association of Risk Professionals Academic Lecture Series (Zürich Chapter)* (Zürich)

April 19, 2007, "Investor Perspectives: New Sources of Derivatives Growth and Sophistication" (Panelist), *24th Annual General Meeting of the International Swaps and Derivatives Association* (Boston)

February 23, 2007, "Risk Management: Evolution or Revolution?" *Rochester-Bern Executive MBA Program Guest Lecture* (Thun)

January 18, 2007, "Risk and Capital Management: Two Worlds or One? Corporate Uses of Structured Finance and Insurance," *Chicago Booth Global Leadership Series* (Bangkok)

January 17, 2007, "Risk and Capital Management: Two Worlds or One? Corporate Uses of Structured Finance and Insurance," *Chicago Booth Global Leadership Series* (Jakarta)

HIGHLY CONFIDENTIAL

October 17, 2006, “Risk Management for Non-Financial Corporations,” *Congress Capacitación Ejecutiva Financial Summit* (Mexico City)

August 9, 2004, “The ART of Risk Management,” *President’s Seminar and Luncheon at the 2004 Annual Meeting of the American Risk and Insurance Association* (Chicago)

July 6, 2004, “Derivatives: Weapons of Mass Destruction, or Smart Bombs?” *Office of the Agricultural Futures Trading Commission of Thailand, Agricultural Futures Exchange of Thailand, Northwestern University Alumni Association of Thailand, Securities Analysts Association, The Stock Exchange of Thailand, and The University of Chicago Alumni Club in Thailand* (Bangkok)

April 1, 2004, “Life after Enron: Can We Govern Ourselves” (Panelist), *19th Annual General Meeting of the International Swaps and Derivatives Association* (Chicago)

August 20, 2003, “The U.S. Economy in the Wake of Recent Corporate Accounting Scandals,” *Stock Exchange of Thailand* (Bangkok)

June 26, 2003, “The Regulation of Corporate Governance: Implications for Investors,” *2nd Annual Friedrich A. Hayek Memorial Lecture – Global Life Insurance Forum* (Bermuda)

August 21, 2003, “Alternative Risk Transfer: Integrating Corporate Finance and Risk Management,” *Standard Chartered Bank and Singapore Association of Corporate Treasurers* (Singapore)

August 1, 2002, “Principles for Sound Investment Risk Management,” *Government of Singapore Investment Corporation* (Singapore)

August 12, 2002, “The Aftermath of Enron: Risk Management, Structured Finance, and Governance in the New World,” *Hong Kong Monetary Authority, Hong Kong Centre for Economic Growth, Hong Kong Institute for Monetary Affairs, Hong Kong University, and HK Securities and Futures Commission* (Hong Kong)

July 30, 2002, “Trends and Issues in the Business of Exchanges and Clearing,” *Hong Kong Exchanges and Hong Kong Securities and Futures Commission* (Hong Kong)

April 17, 2002, “Global Derivatives Public Policy Issues” (Panelist), *17th Annual General Meeting of the International Swaps and Derivatives Association* (Berlin)

April 10, 2002, “Alternative Risk Transfer as an Innovation in Corporate Finance,” *Euroforum HandelsZeitung Konferenz* (Zürich)

February 6-7, 2002, “Alternative Financial Insurance Products – A Look at Developments 1 Year Later” (Panelist), *Professional Liability Underwriting Society D&O Symposium* (New York)

January 23, 2002, “The ART of Risk Management and Capital Structure Optimization,” *The University of Chicago Booth School of Business – Guest Lecture* (Barcelona).

December 7, 2001, “Optimizing Corporate Capital Structure Using Risk Management,” *Zurich Insurance Group* (Zürich)

November 2001, “The Role and Future of Transactional Insurance Products” (Panelist), *Professional Liability Underwriting Society Annual Conference* (New York)

June 29, 2001, “Enhancing Clearinghouse Integrity with Synthetic Capital” (Panelist), *Futures Industry Association Expo* (Chicago)

June 14, 2001, “Risk Management and Shareholder Value,” *CPS Value Integration Conference* (Nice)

April 12, 2001, “Risk Budgeting: A Novel Concept or a Return to Investments 101?” *Investment Analysts’ Society (Chicago Chapter)* (Chicago)

May 25, 2000, “Liquidity Risk Management: Lessons from Metallgesellschaft,” *RMA Chief Risk Officer Forum* (Chicago)

May 17, 2000, “From Risk Management to Better Management,” *Futures and Options World* (New York)

October 20, 1999, “Russell/Mellon Value at Risk: Applications & Scope,” *Russell/Mellon Analytical Services Annual Client Conference* (Bretton Woods) – with C. Cockburn

HIGHLY CONFIDENTIAL

March 25, 1999, "Impacts and Implications of Capital Controls on Derivatives and Risk Management," *14th Annual General Meeting of the International Swaps and Derivatives Association* (Vancouver)

March 8, 1996, "Relations between Insurance and Derivatives: Applications from Catastrophic Loss Insurance," *Competitive Enterprise Institute Conference on Insurance Reform* (Washington, D.C.)

TESTIMONIAL EXPERIENCE

August 2019 – Deposition Testimony, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (PAE)

August 2019 – Deposition Testimony, *Jeffrey Laydon et. al. v. The Bank of Tokyo-Mitsubishi UFJ, Ltd., et. al.* (S.D.N.Y.), No. 12-CV-3419 (GBD)

September 2018 – Deposition Testimony, *Krukever et. al. v. TD Ameritrade, Inc., and TD Ameritrade Futures & Forex LLC* (S. D. Fla.), No. 18-21399-CIV-ALTONAGA/GOODMAN

April 2017 – Deposition Testimony, *In RE LIBOR-Based Financial Instruments Antitrust Litigation* (S.D.N.Y.), MDL No. 2262, 11 Civ. 2613

October 2015 – Deposition Testimony, *Federal Home Loan Mortgage Corporation v. Deloitte & Touche LLP* (S. D. Fl.), No. 1:14-cv-23713-UU

June 2015 – Deposition Testimony, *In re Countrywide Financial Corp. Mortgage-Backed Securities Litigation (Federal Deposit Insurance Corporation as Receiver for United Western Bank v. Countrywide Financial Corporation, Countrywide Securities Corporation, Countrywide Capital Markets, LLC, CWALT, Inc., CWMBS, Inc., Bank of America Corporation, and UBS Securities LLC)* (C. D. Cal.), No. 2:11-ML-02265-MRP-MAN (No. 2:11-CV-10400-MRP-MAN)

December 2014 – Deposition Testimony, *The People of the State of New York, by Eric T. Schneiderman, Attorney General of the State of New York v. Maurice R. Greenberg and Howard. I. Smith* (Supreme Court of the State of New York, County of New York), No. 401720/05

October 2014 – Deposition Testimony, *In re: North Sea Brent Crude Oil Futures Litigation* (S.D.N.Y.), No. 1:13-md-02475 (ALC)

May 2014 – Deposition Testimony, *Lehman Brothers Holdings Inc., and Official Committee of Unsecured Creditors of Lehman Brothers Holdings Inc. v. JPMorgan Chase Bank, N.A.* (Bankr. S.D.N.Y.), No. 10-03266 (JMP)

October 2013 – Congressional Testimony, "Statement of Christopher Culp on 'The Future of the CFTC: Perspectives on Customer Protections,'" *U.S. House of Representatives, Committee on Agriculture, Subcommittee on General Farm Commodities and Risk Management*

June 2013 – Deposition Testimony, *Deutsche Bank AG v. Deloitte & Touche LLP*, No. 11-43773 Civ. 32 (Miami-Dade County, Florida) and *Ocala Funding LLC v. Deloitte & Touche LLP*, No. 30957 Civ. 30 (Miami-Dade County, Florida)

January 2012 – Deposition Testimony, *Allied Irish Banks, p.l.c. v. Bank of America, N.A., and Citibank, N.A.*, No. 03 Civ. 3748 (DAB) (GWG) (S.D.N.Y.)

October 2011 – Trial Testimony, *Prudential Retirement Insurance and Annuity Company v. State Street Bank and Trust Company and State Street Global Advisors*, No. 07 Civ. 8488 (S.D.N.Y.)

May 2011 – FINRA Testimony, *US Airways, Inc., v. Roland Hansalik et. al.*, FINRA Arbitration No. 09-06905

July 2010 – Deposition Testimony, *Securities and Exchange Commission v. Angelo Mozilo, David Sambol, and Eric Sieracki*, No. CV 09-03994 JFW (MANx) (C. D. Cal.)

April 2010 – Deposition Testimony, *Prudential Retirement Insurance and Annuity Company v. State Street Bank and Trust Company and State Street Global Advisors*, No. 07 Civ. 8488 (S.D.N.Y.)

December 2009 – FINRA Testimony, *GSI Commerce Solutions, Inc., v. Lehman Brothers Inc. et. al.*, FINRA Arbitration No. 08-02857

HIGHLY CONFIDENTIAL

June 2009 – Congressional Testimony, “Statement of Christopher L. Culp on ‘The Effective Regulation of Over-the-Counter Derivatives Markets,’” *U.S. House of Representatives, Committee on Financial Services, Subcommittee on Capital Markets, Insurance, and Government-Sponsored Enterprises, 111th Congress, First Session – Serial No. 111-41*

December 2008 – Deposition Testimony, *The Bank of New York Trust Company, N.A., as Trustee, v. Franklin Advisers, Inc., et. al.* Case No. 07-CV-1746 (VM) (S.D.N.Y.)

February 2008 – Trial Testimony, *Solutia Inc. v. Citigroup Global Markets Inc., Goldman Sachs Credit Partners L.P., Deutsche Bank Securities Inc., & Deutsche Bank Trust Co. Americas*, No. 08-01057 (PCB) (Bankr. S.D.N.Y.)

February 2008 – Deposition Testimony, *Solutia Inc. v. Citigroup Global Markets Inc., Goldman Sachs Credit Partners L.P., Deutsche Bank Securities Inc., & Deutsche Bank Trust Co. Americas*, No. 08-01057 (PCB) (Bankr. S.D.N.Y.)

February 2008 – Trial Testimony, *Schering-Plough Corporation v. United States*, C. A. No. 05-2575(KSH) (D. N. J.)

January 2008 – Trial Testimony, *Schering-Plough Corporation v. United States*, C. A. No. 05-2575(KSH) (D. N. J.)

November 2007 – Deposition Testimony, *Schering-Plough Corporation v. United States*, C. A. No. 05-2575(KSH) (D. N. J.)

May 2003 – Deposition Testimony, *In re The Limited Inc. Shareholders Litigation*, Consolidated C. A. No. 17148-NC (Del. Ch.)

October 2001 – Direct, Rebuttal, and Sur-rebuttal Testimony, *Commonwealth Edison Company Petition for Approval of Delivery Services Tariffs and Delivery Services Implementation Plan and for Approval of Certain Other Amendments and Additions to its Rates, Terms and Conditions*, No. 99-0117 (State of Illinois, Illinois Commerce Commission)

HIGHLY CONFIDENTIAL**APPENDIX B: MATERIALS RELIED UPON**

The materials shown in this Appendix are *new* materials relied upon for the purposes of this report. Materials on which I relied in the Culp Opening Report that are also relied upon here are not shown below.

Court Documents:

Memorandum of Law in Support of Plaintiffs' Motion to Exclude the Expert Report and Testimony of Dr. Christopher L. Culp, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (October 1, 2019).

Expert Reports:

Expert Rebuttal Report of Christopher L. Culp, Ph.D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (June 18, 2019).

Errata Sheet for the Expert Report Christopher L. Culp Dated June 18, 2019, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (August 22, 2019).

Expert Reply Report of Darrell Duffie in Support of Class Plaintiffs' Motion for Class Certification, *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (October 1, 2019).

Expert Rebuttal Report of Mark Grinblatt, Ph.D., *In re Interest Rate Swaps Antitrust Litigation* (S.D.N.Y.), No. 16 MD 2704 (October 1, 2019).

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